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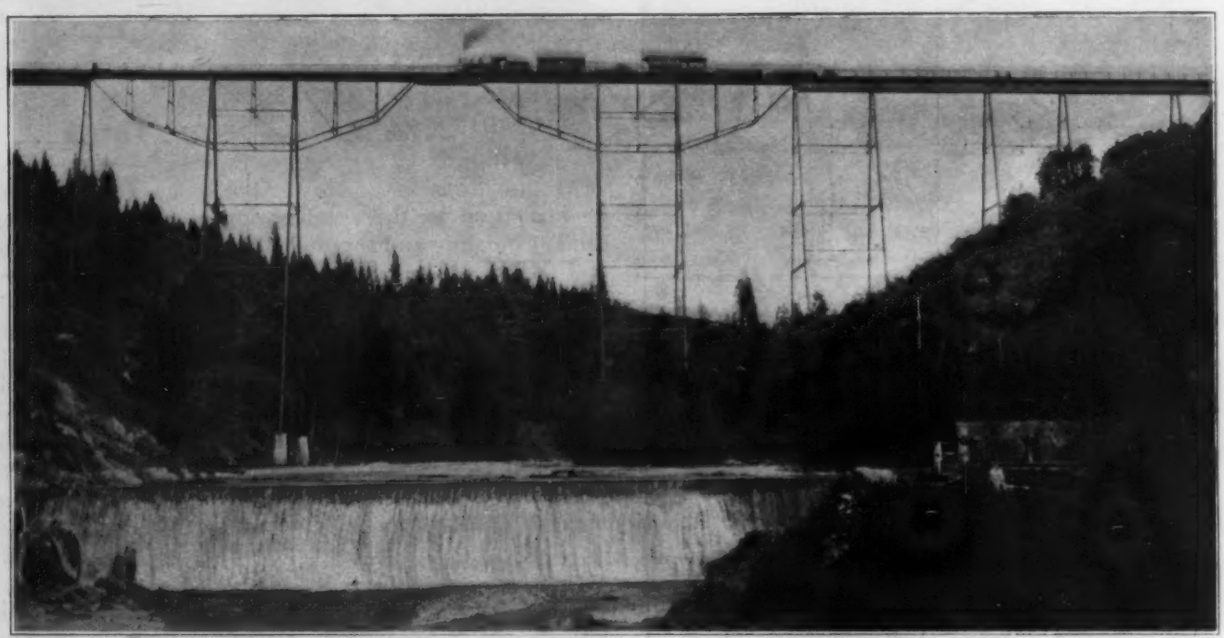
ENLARGING THE BEAR RIVER DITCH

BY RUDOLPH W. VAN NORDEN.[1]

Water ditches or canals in earth are as much a part of California's industrial development as are the highways or bridges or any other works or man indigenous to the country. Since the beginning of water development these ditches have been built, enlarged, rebuilt, and in many cases abandoned, with scarcely as much public notice as might be given by a local news item. To describe, then, as a feat in modern engineering design and construction, the enlargement of 24 miles of an old water ditch must presuppose a work of unusual interest to the engineering world as well as the commonwealth directly benefited.

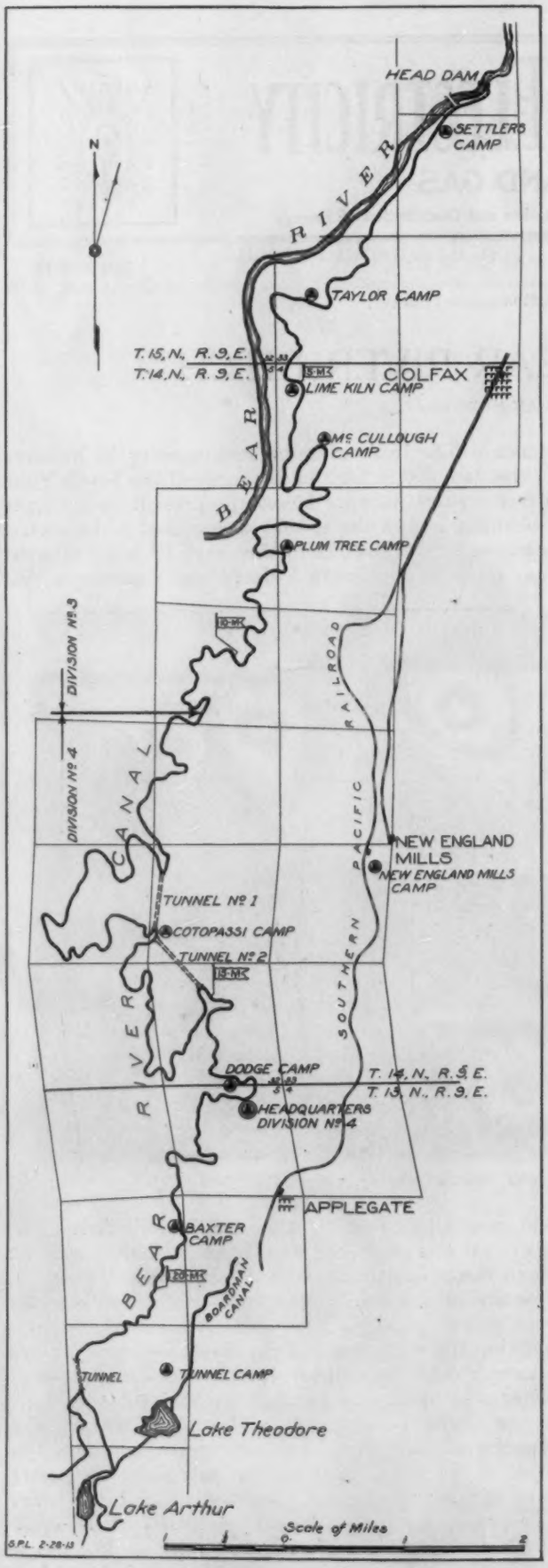
The enlargement of the Bear River ditch is not only interesting from the design and magnitude of the work and the great power system which it will make possible, but also from the circumstances which throw restrictions about it, hence requiring the greatest skill and ingenuity in its conception and realization.

Briefly, the plan consists in increasing the storage capacity of Lake Spaulding to 4,000,000,000 cu. ft., which will be 15 times its present capacity, by building a new dam 300 ft. high in the gorge of the South Yuba River a short distance below the present dam. Lake Spaulding is now the second largest, and is the receiving lake for the waters of the other 19 lakes of what was formerly the South Yuba Water Company's system, now a part of the Pacific Gas and Electric Company. Water from the new Lake Spaulding will be taken through a tunnel with a capacity of 450 sec. ft. flow and which will contain, near its portal, a single unit power plant of 6500 h.p. maximum capacity, utilizing the static head of the water between the full reservoir and the tunnel level. From this tunnel, water will be carried through a canal 10 miles long to the Drum power plant. This plant will have a capacity of 53,600 h.p., and be located on the south bank of the Bear River. From this point the water is to be taken in a second canal a distance of 8.5 miles to a power plant, now known as No. 2, where a fall of 826 ft. is possible, giving a capacity of 33,250 h.p. Again the water is taken up and carried through a



Head Dam Bear River Canal and Nevada County Narrow Gauge Railroad Viaduct.

[1]Member A. I. E. E., A. S. C. E.



Line of the Bear River Enlarged Canal.

canal a distance of 7 miles to plant No. 3. Here a drop of 500 ft. is possible and a plant capacity of 20,000 h.p. The water from this plant will be discharged into Bear River only to be diverted after flowing in the river about a mile, into the Bear River ditch, the subject of this paper.

It is for the purpose of carrying the increase of 350 sec. ft. from the storage waters in Lake Spaulding that this enlargement is necessary. At a point between Applegate and Clipper Gap, 22.5 miles below the intake (along the new line) there is a drop in the ditch of 340 ft. This forms the site of power house No. 4; it will have a capacity of 13,400 h.p. Continuing to a point near Bowman a receiving and equalizing reservoir, with a capacity of about 400 acre ft., to control the supply of water to power plants 5 and 6 and the irrigation requirement. From here the canal will continue to a point midway between Auburn and Newcastle, where a drop of 530 ft. forms the site for power house No. 5, with a capacity of 20,000 h.p. Again the water is carried in a canal to a point west of the town of Ophir, where a drop into Auburn ravine of 450 ft. gives to power house No. 6 a capacity of 13,400 h.p. Beyond this point the water will be distributed over a territory of 90,000 acres in Placer and Sacramento counties for irrigating the orange and deciduous fruit orchards. The total power plant capacity of the new system will be 160,150 h.p.

The Bear River Ditch.

The South Yuba Water Company's system has two main divisions. This has always been so since its formation by the combination of the South Yuba Canal Company and the Bear River and Auburn Water and Mining Company. These divisions begin geographically with the parting of the ways in Bear Valley, where part of the water which is taken out of the gorge of the South Yuba, below Lake Spaulding, is carried in a ditch and flume along the north wall of Bear Valley and Little Bear Valley, to furnish the supply for the Nevada division and the cities of Grass Valley and Nevada City, while the remainder of the water after passing through Bear Valley is diverted at three points from Bear River to supply the power plants formerly of the Central California Electric Company and the irrigation system.

The first diversion from Bear River is immediately below the lower end of Bear Valley proper and the ditch which carries this water and which follows the south bank of Bear River is known as the Boardman. It is not of interest in this article.

The second diversion is north of the town of Colfax, immediately below the junction of Greenhorn Creek and also the crossing of the Nevada County narrow gauge railroad. This is known as the Bear River ditch; it originally comprised the main canal of the old Bear River and Auburn Water and Mining Company, and is the one to which this description is devoted.

The third diversion is about 16 miles below the second, and supplies water to the western part of Placer County; this is known as the Gold Hill ditch. Like the first, it will not be described.

The original log dam was twice replaced by similar structures. In 1908 the third log dam failed and

this was replaced during the fall of 1909 by a masonry dam, which was completed December 30th of that year. The new dam was designed and constructed under the direction of the late James H. Wise. It is of cyclopean rubble concrete of gravity section, the downstream face being almost vertical, the foundations being carried to bedrock. The southern end of the dam terminates in a concrete head structure with double sluice gates operated by Crane screw stem standards. Below the gates the outer concrete wall forms an easement weir. This head will be enlarged to accommodate the increased water flow into the enlarged canal.

Plan of Enlargement.

With the work of development at Lake Spaulding well under way the importance of enlarging the system throughout to handle the volume of water which

Appearance of Ground After Blasting Ahead of Steam Shovel.

will be liberated by the additional storage becomes a matter of prime importance.

The study of this enlargement was made by the late Mr. James H. Wise as a part of the general plan of development of the South Yuba system. It is undoubtedly the logical method to co-ordinate with the development further up the Bear River.

Marion 1½ Yd. Steam Shovel.

Two factors enter into the problems which govern the work and make its successful outcome, the result of careful organization and good engineering skill. In the first place, this ditch supplies water for irrigation to about 15,000 acres, mostly in deciduous fancy fruits. Any interruption in the supply of water between the first of April and the first of November would be disastrous. Not only would these acres of highly paying orchards be ruined, causing the loss of thousands of dollars to both the orchardists and the company, but the right of personal convenience and necessity would be violated. The problem presented, therefore, to the engineers of the company resolved itself into a study of the economic methods of construction, coupled with a speed sufficient to complete the work of enlargement from a capacity of 1600 miners inches, equal to 40 sec. ft. flow, to a capacity of 14,000 miners inches, or 350 sec. ft., and have water flowing in the canal by April 1st.

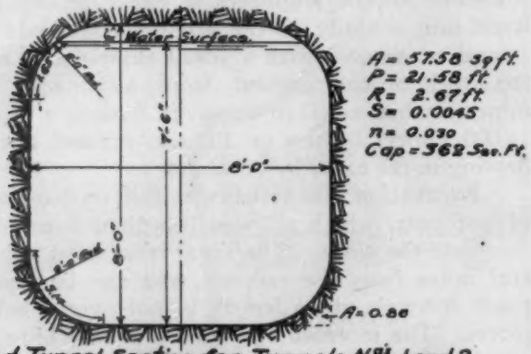
Excavation was actually started on November 9th of last year, which allowed less than five months to complete the work. The canal is, at most points, several miles from the railroad, and can be reached by roads throughout its length in not over a half dozen places. The intervening country is very hilly and the canal itself is, in many places, on forbidding sidehills.

The plan of enlargement is very simple and with but two exceptions of any importance, is a widening and deepening of the old canal and the building of larger and more substantial flumes where it has been found expedient to still use timber flume. The two notable exceptions, where the old canal is not followed is where two long detours or loops are cut out by driving tunnels. Here the work was favored by the fact that the tunnels are almost end to end, there being a distance of but 787 ft. between the outlet of tunnel No. 1 and the upper portal of No. 2. The distance along the old ditch eliminated by these tunnels is 8.6 miles; the length of No. 1 tunnel is 2,112 ft., and of No. 2 is 1,975 ft., or a total length of tunnels of 4,087 ft. equal to 0.77 mile. This subtracted from the total ditch length eliminated, leaves 7.83 miles as the net distance eliminated.

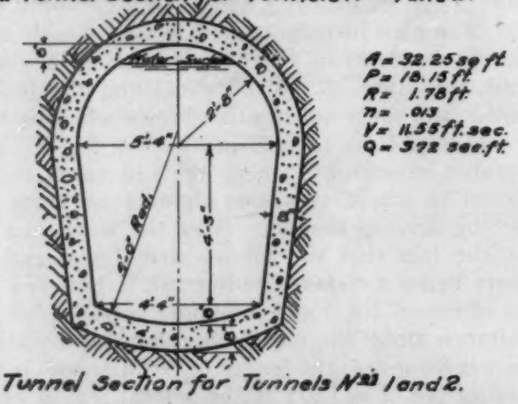
Tunnel No. 1 is practically all in rock, but the second has some timbering. The rock formation is a serpentine common to this section, but is, as a rule, sufficiently homogeneous to be self supporting. Where this is the case, it is not proposed to use any lining and the tunnel section is of sufficient area to pass the full capacity of the canal. This area is 57.58 sq. ft., and the coefficient of roughness, "n" is assumed in calculating the cross section, at 0.030. Where lining is necessary an average thickness of concrete of 8 in. is used, the area of cross-section is reduced below the unlined section of 32.25 sq. ft., and the coefficient of roughness of 0.013 is used. The egg shaped section has been adopted for economic flow conditions, while the square section with rounded corners, for economic excavation.

The tunnels have been driven from four headings each. The ground surface at no place is high above the bore and shafts 85 ft. and 59 ft. deep respectively, were driven near the center point of each tunnel to permit of working each from two extra headings. In the upper portal of No. 1, considerable water was encountered which required pumping. This was accomplished by means of a 3 in. motor driven centrifugal pump, and at the lower portal by a small duplex steam pump, operated by compressed air. An odd condition at the upper

portal made the beginning of this work awkward as the approach to the tunnel is across almost flat ground in which the canal will form a deep trench. As this part of the work had not been completed when the tunnel portal was opened, necessitated raising the muck by a switchback track, and also pumping the water.



Unlined Tunnel Section for Tunnels N^os 1 and 2.



Lined Tunnel Section for Tunnels N^os 1 and 2.

Bear River Canal Tunnel Section.

The work of excavation in the tunnels has been rapid, the average work per day from eight headings being about 60 ft. With 150 days to work, it was calculated that a daily average of about 52 ft. would be required. The actual average has been considerably in excess of this calculation.

Work on the tunnels did not start until the middle of December or a month and a half after the time of commencing calculation, but the work in tunnel No. 1 is now almost up to the progress calculation curve and will soon overtake it, while tunnel No. 2, at the present rate of work, will be finished within the time limit.

The tunnel camp, known as the "Cotopassi Camp," is conveniently located between the tunnels and at the forks of a county road. The 60 kilovolt transmission line of the company passes close by, and this is tapped for the power supply at this camp.

The substation is a corrugated iron building containing three 500 kw. Stanley, oil-immersed and water cooled lowering transformers. These are "Y" connected to the 60 kilovolt circuit, the primary winding being 31,213 volts and the secondary, 2490 volts, "delta" connected to the three-phase feeder lines. The motor equipment is all served from a 440 volt three-phase system. In order to obtain this operating voltage, there are installed, one bank of 50 kw., and one bank of 37.5 kw. power transformers wound for 2400 volts primary and 440 volts secondary. Two three-pole 2400 volt oil circuit-breakers complete the equipment. Outside the transformer building, there are mounted a set of pole type disconnecting switches and poletop fuses in glass tubes.

Adjoining the transformer house is the compressor house. This contains one two-stage air compressor, cylinders 16 in. x 12 in., belted to and driven by a 440 volt, 720 r.p.m. General Electric induction motor of 100 h.p. capacity; also one 19 in. x 14 in., two-stage compressor similarly driven by a 150 h.p. motor of same make. The compressors were furnished by the Chicago Pneumatic Tool Company.

The drills used in the tunnels are 3.25 in. Ingersoll-Rand and Sullivan, two drills being used at each heading. Induction motor driven centrifugal blowers placed outside the portals supply air in the tunnels for ventilation.

Below the outlet portal of No. 2 there is a deep cut 425 ft. long which terminates where the old line of canal is joined at the turn of a sharp loop where a gulch was crossed.

The third tunnel on the line is the one which formed part of the old canal. This is being enlarged to practically the dimensions of the other tunnels. For this work a separate compressor camp near Lake Theodore was installed. The substation is 14 ft. x 20 ft. and contains two 100 kw. lowering transformers, the remaining equipment being practically similar to the Cotopassi station. The compressor house has one 12½ x 12 in. Ingersoll-Seargent compressor driven by a 100 h.p. General Electric 440 volt induction motor.

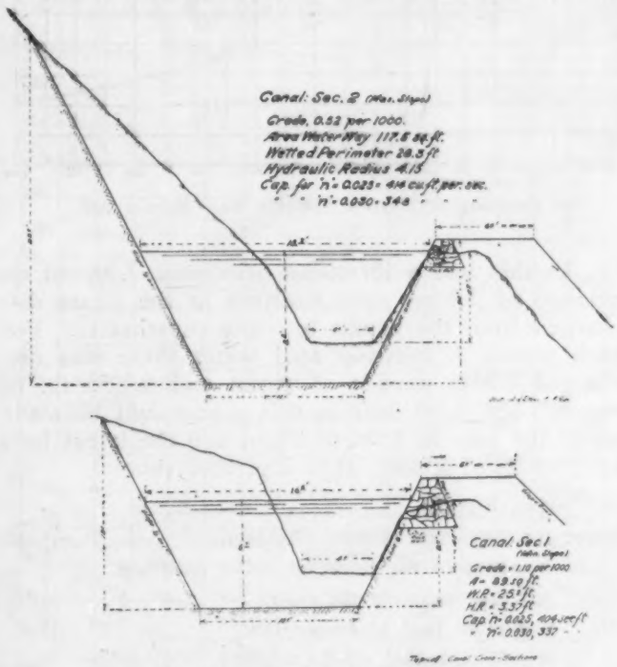
Canal.

The new section of the canal in earth has a trapezoidal section. The bottom width is 10 ft., the width at the berm is 16.6 to 18.3 ft., the depth below the berm is 8 to 9 ft. and the depth of water when running full will be 6.7 to 8.3 ft., all depending upon the grade. The slope of the sides is 1 horizontal to 2 vertical.

Three-Horse Wood Team in Enlarged Canal.

In enlarging, the outer slope of the old ditch is not disturbed, in fact the greatest care has been taken that no shattering of the old berm should take place, this having been proven thoroughly permanent from long use. The new bottom is about 2 ft. below that of the old ditch and the new berm is carried up about 2 ft. aboev the old. Excavation is entirely from the hillside slope and the bottom. The excavation per linear foot of the old ditch was 1.5 to 4 cu. yd., while that of the enlarged canal is 2 to 4 cu. yd. additional.

The latter amount is the net excavation, and this is piled on the old berm. To depend entirely upon banked earth as the outer wall of a canal in earth would be in most cases be disastrous because the action of water and the unavoidable permeability would soon start leaks from which rapid disintegration would result. In building the new berm, after the earth has become well settled from the constant passage along the canal of men and horses, it is cut back, the cut being carried about a foot into the old berm and in this notch is laid a dry rock wall of gravity dam section. Wherever there are soft places in the old ditch wall, this wall is carried to the bottom of the cut. A number of devices have been adopted for reinforcing the outer

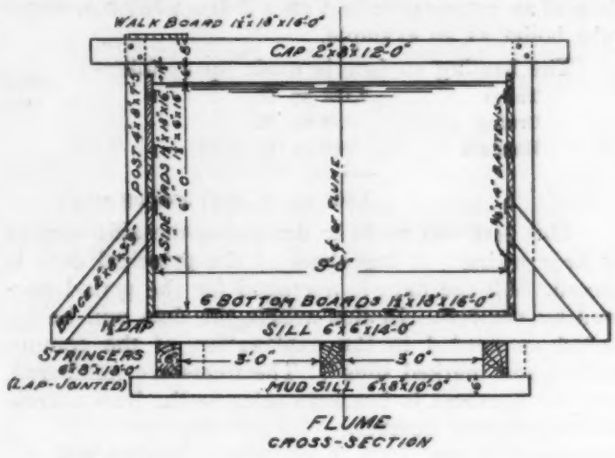

Canal: Sec. 2
Grade, 0.52 per 1000.
Area Water Way 117.6 sq. ft.
Wetted Perimeter 29.3 ft.
Hydraulic Radius 4.15
Cap. for 'n' = 0.025 = 414 cu. ft. per sec.
" 'n' = 0.030 = 348 "
Canal Sec. 1
Grade = 1.1 ft. per 1000
A = 83.20 ft.
W.P. = 25.1 ft.
H.R. = 3.32 ft.
Cap. for n = 0.025, 404 sec. ft.
" n = 0.030, 337 "

Typical Sections of Old and Enlarged Canal.

berm on curves and places where the outer wall is liable to be weak. In the former instance, at points where the current would cause erosion because of the curve, a timber riprap is used. This consists of sills embedded in the ditch wall, either held by dry rock wall or by concrete. To the sills are spiked heavy planking which receive the force of the current. In a number of cases it has been found advisable, either because of the steepness of the general ground surface, the original thinness of the old berm or for some weakness that might develop, to substitute a concrete wall and lining.

Timber Flume.

The use of timber flume has been very carefully considered, as it is, at best, a construction of high depreciation values. There are, however, often found places where it is economically advisable. In this work, every precaution has been taken in the design and construction of the flumes. The ground surface has been well leveled and cleared above and below to prevent damage from falling trees and rolling rocks. Two sizes of flume have been adopted as standard, the capacity in either case being practically the same. The smaller size used within the first 5½ miles where the grade is 1.1 ft. per 1000. The larger size is used in the next section where the grade is 0.52 ft. per 1000. The smaller flume, of which a section is shown is 9 ft. wide and 6 ft. high inside measurement and contains 1,695.8 ft. B.M. of lumber. The larger flume is 11 ft. wide inside and when up to capacity, runs water 6½ ft. deep. The lumber content is 2,193.33 ft. B.M. The sills, stringers and uprights are heavier than ordinary past practice; the lining is 1½ in. tim-



S = 0.0011
A = 54 SQ. FT.
n = 0.013
V = 7 FT. PER SECOND.
Q = 380 CU. FT. PER SECOND.

MATERIAL FOR 16 FT. SECTION

LUMBER				NAILS		
LOCATION	PCS.	DIMENSIONS	FEET B.M.	NO.	SIZE	NO. LBS.
SIDE & BOT. BDS.	14	1½ x 18 x 16	504	140	30 d	7
CAPS	10	2" x 8" x 12'	160	300	20 d	11
POSTS	3	4" x 6" x 16'	213.3	400	16 d	9
BOX SILLS	5	6" x 6" x 14'	210	200	6d	1
STRINGERS	3	6" x 8" x 18'	216			
MUD SILLS	5	6" x 8" x 10'	200			
QUARTER BR.	24	2" x 8" x 16'	533			
WALK BOARD	1	1½ x 18" x 16'	36			
SIDE BOARDS	2	1½ x 6" x 16'	24			
BATTENS	13	⅞ x 4" x 16'	432			
TOTAL, PER BR.			1,639.8			28

Bear River Canal Flume

ber 18 in. wide of clear local pine. The stringers are mounted on mud sills laid on the ground.

Wasteways.

There are seven wasteways installed throughout the length of the canal. These are of concrete and are in reality a concrete lined section of the canal with an outlet, as they preserve the trapezoidal form of the canal. At the outlet, the bottom of the canal is dropped 3 ft., which forms a trap for sand and other debris and prevents the flow in the ditch beyond the wasteway when the gates are opened. The gates are of timber and slide in channel guides and are raised and lowered by a rack and pinion gear. The concrete wing walls and apron are carried far enough away from the canal wall to prevent any possibility of erosion or damage of any kind to the canal during discharge. There is an average of 50 cu. yd. of concrete in each structure, the only reinforcement being at corners and in the arch over the gateway.

(To be continued.)

METHOD OF COMPUTING THE DATA OF A BOILER TEST.

BY J. P. ZIPF.

The best method of presenting the recorded data of a boiler test is by what are known as log sheets. The data is plotted as ordinates against time as abscissae. This has the advantage of showing the relative magnitude of changes as they occur, and the relation of certain events, one with another in a way not possible in a column of figures. We will take the data of an evaporative test on a 2 drum 750 h.p. water tube boiler as an example.

The heating surface is made up as follows:

Tubes	7,123 sq. ft.
Drums	199 sq. ft.
Headers	186 sq. ft.
	7,509 sq. ft. total heating area.

This test was made to determine the efficiency at or near rating. A log sheet of the principal data is shown. All the data is averaged for the period covered by the test. In this article the data will be inserted as needed in the explanation of the computations and marked thus †. The items are numbered, and the numbers in brackets refer to the item corresponding to that number.

†(1) Length of run ..... hours 2

†(2) Barometer—inches of mercury 30.2

(3) Barometer—lb. per sq. in. $\frac{(2)}{29.92} \times 14.7 = 14.8$

The gauges had been previously calibrated and the pressures given are the corrected pressures.

†(4) Pressure of saturated steam lb. sq. in. 183.0

Z(5) Pressure of superheated steam lb. sq. in. 177.7

The drop in pressure through the superheater was 5.3 lb.

(6) The absolute pressure of the superheated steam is (3) + (5) = 192.5 lb. per sq in.

(7) The temperature of saturated steam corresponding to this pressure is ..... 378.7° F.

†(8) Average temperature of the superheated steam (including the emergent stem correction) ..... 435° F.

†(9) Degree of superheat (8) — (7) 56.3

†(10) Average temperature of feed water ..... 186° F.

From steam tables (Marks & Davis, p. 52)

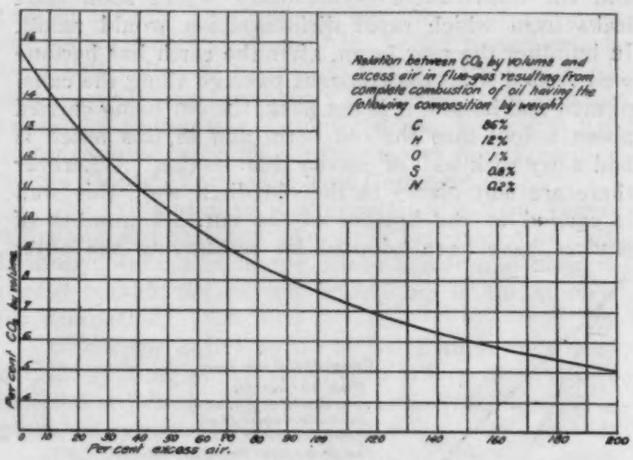
(11) Total heat in one lb. of steam, 192.5 lb. pressure and 56.3° superheat ..... 1232.4 B.t.u.

(12) Total heat in 1 lb. of feed water (M. & D., p. 11) ..... 153 B.t.u.

(13) Total heat input per lb. (11) — (12) = ... 1078 B.t.u.

Boilers are rated on their evaporation at atmospheric pressure, or by their ability to supply 970.4 B.t.u. to each lb. of water; 970.4 B.t.u. is just sufficient to transform 1 lb. of water at 212 deg. F. into steam at 212 deg. F., and gives rise to the expression "evaporation from and at 212 deg." (evap. f & a 212 deg.) If in (13) evaporation had taken place from and at 212 deg. F., $\frac{1078.5}{970.4}$ (or 1.1114) lb. of water evaporated. This factor (1.1114) is called the factor of evaporation, and is expressed by $\frac{H - h}{970.4}$ where H is the total heat in 1 lb. of discharged steam and h the total heat in 1 lb. of entering feed water.

Had the boiler only supplied saturated steam the "quality" of the steam would have been taken.


Relation between CO₂ by volume and excess air in flue-gas resulting from complete combustion of oil having the following composition by weight.
C 86%
H 12%
O 1%
S 0.8%
N 0.2%
Per cent CO₂ by volume
Per cent excess air.

Relation of Carbon Dioxide and Excess Air

In this test a throttling calorimeter showed an average of .55 per cent moisture in the steam discharged from the drums into the superheater. For each pound of entering feed water there was discharged 0.9945 pounds of steam and 0.0055 lb. of water. The total heat in this case would be made up of the heat in 1 lb. of liquid and the latent heat in .9945 lb. of steam. It is expressed thus:

$$H = (h + xL).$$

where H = total heat in 1 lb. of steam.

h = heat of the liquid at boiler condition.

x = the quality of the steam.

L = latent heat of evaporation.

$H = 351.5 + .9945 \times 845.9 = 1192.6.$

This value is not needed unless it is desired to separate the work of the boiler into two parts: the evaporation of water and the superheating effect,

†(14) Total water weighed ..... 202,844 lb.

(15) Equivalent evaporation f & a 212° F. = (14) × factor of evaporation ..... 224,440 lb.

(16) Average hourly rate (14) ÷ (1) ..... 25,355 lb.

(17) Average hourly equivalent evaporation (16) ÷ (1) ..... 28,180 lb.

1 boiler h.p. requires an evaporation f & a 212° of 34.5 lb. of water per hour, hence

(18) Power developed (17) ÷ 34.5 ..... 817 b.h.p.

(19) Builders' rating ..... 750 b.h.p.

(20) Per cent of rating developed 100 × (18) ÷ (19) ..... 108.7 %

The average hourly rate is shown on the log sheet curve.

(21) Total oil consumed ..... 15,107 lb.

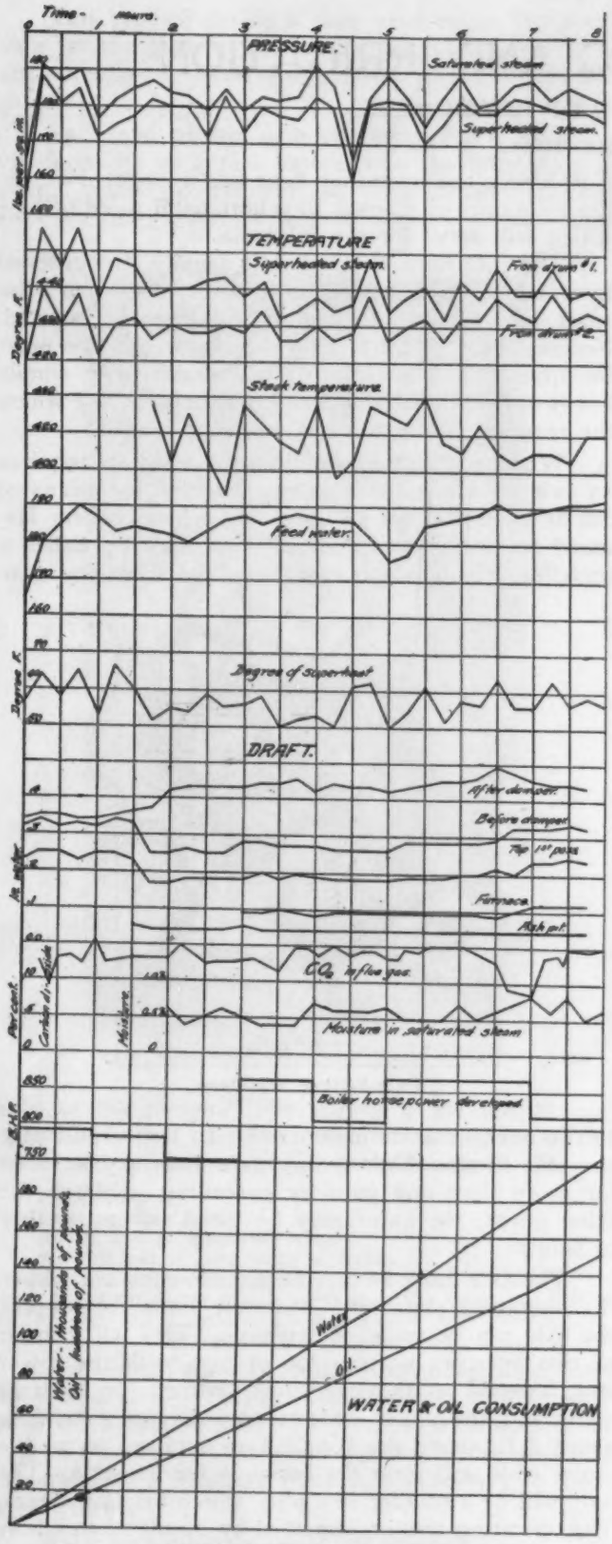
(22) Per cent of moisture in the oil ..... 1.0 %

Fuel consumption corrected for moisture (21) ×] 1.00 — (22)] ..... 14,956 lb.

(23) Average hourly rate—oil as fired ..... 1,888.4 lb.

(24) Average hourly rate,—oil corrected for moisture ..... 1,869.5 lb.

(25) Gravity of the oil ..... 15.2 °Be.



Typical Boiler Test Log Sheet.

(26)	Calorific value of oil free from moisture B.t.u. per lb.....	185.84
	The economic results of a boiler test are expressed as evaporation per lb. of oil.	
(27)	Actual evaporation per lb. of oil as fired (16) ÷ (23)	13.42 lb.
(28)	Evaporation f & a 212° per lb. of oil as fired (17) ÷ (23)	12.42 lb.
(29)	Evaporation f & a 212° per lb. of dry oil (17) ÷ (24)	15.06 lb.
(30)	The heat output of the boiler as steam per lb. of dry oil (29) × 970.4....	14,690 B.t.u.
(31)	Gross boiler efficiency (30) ÷ (26).....	18.65 %
(32)	Steam supplied to burners per lb. of oil (estimated)	.5
(33)	Oil fired per minute (23) ÷ 60.....	31.4 lb.
(34)	Steam used for atomization per minute (32) × (33)	15.7 lb.
(35)	Water evaporated per minute (16) ÷ 60..	422.6 lb.
(36)	Per cent of steam used by burners (34) ÷ (35)	3.72 %

The net efficiency is the ratio of the heat taken away in the net steam output to the heat per lb of dry oil.

The net quantity of steam per lb. of oil as fired is (27) — (32) = 12.92 lb.

This would represent a heat output of 12.92 × 970.4 × factor of evaporation or 13,934 B.t.u.

The efficiency is then 13,934 ÷ [(26) × 1.00 — (22)], since the heat output is based on oil as fired, and the calorific value of the fuel is given for dry oil.

(37)	Net efficiency .....%	75.76
†(38)	Average CO_2 .....% by volume	12.2

Sufficient data for a heat balance was not taken but the method of making a heat balance was outlined in the Journal, November 18, 1911. The carbon dioxide present indicates about 18 per cent excess air. This is obtained from the curve showing the relation between excess air and CO_2 by volume for an average California crude oil. This curve is due to Mr. R. F. Chevalier. An approximate heat balance for 1 lb. of fuel can be made as follows:

There is theoretically required for combustion about 14 lbs. of air for 1 lb. of fuel. As there is here 18 per cent excess air the total weight of the gas is 1 + (14) × (1.18) = 17.5 lb.

†(38)	Average stack temperature	420° F
(39)	Average external air (assumed).....	80° F.

If the oil contains 12 per cent of hydrogen (H) as given on the curve for an average California oil there will be 9 H (or 1.08) lb. of water formed. There will then be 17.5 — 1.08 = 16.42 lb. of dry flue gas. Five-tenths lb. of steam were used to atomize 1 lb. of oil, hence for each lb. of fuel 1.08 + 0.50 (or 1.58) lb. of water vapor is included in the flue gas. One lb. of oil as fired contains .99 × 18,584. or 18,397 B.t.u.

	B.t.u.	%
Heat carried away in steam (13) × (27) = ...	14,473	= 78.67
Heat carried away in dry flue gas 16.42 × [(38) — (39)] × .24 = ...	1,341	7.29
Heat carried away in water vapor 1.58 [1150.4 — 48.0 + (38) — 212.48] = ...	1,900	10.32
Radiation and other losses unaccounted for....	683	3.72
Heat in 1 lb. of fuel as fired.....	18,397	100.00

The boiler efficiency is always referred to moisture free oil, but the heat balance, being a summary of actual items, is based on oil as fired.

All losses unaccounted for are included as radiation, which remains after all measureable losses are subtracted from the heat value of the oil.

ELECTRICAL PUMPING AND IRRIGATION

DETAILS AND DESIGN OF HEADGATES.

BY B. A. ETCHEVERRY.

Gate lifting device. When either opening or closing a gate, the lifting force must overcome the sum of the friction produced by the pressure on the grooves of the weight of the gate. The starting force must be equal to the coefficient of static friction multiplied by the pressure. The coefficient of kinetic friction is less than the static coefficient; it diminishes gradually with an increase of speed. The following table gives the coefficients of static friction applicable to gate bearings not lubricated.

Coefficient of Static Friction.

Timber on timber	0.5 to 0.2
Metal on metals	0.25 to 0.12
Timber on metal	0.6 to 0.2

	Lbs. per sq. in.
Wrought iron on wrought iron, 0.25 for pressure of	187
Wrought iron on wrought iron, 0.41 for pressure of	560
Wrought iron on cast iron, 0.28 for pressure of	187
Wrought iron on cast iron, 0.37 for pressure of	560
Steel on cast iron, 0.30 for pressure of	187
Steel on cast iron, 0.36 for pressure of	560
Brass on cast iron, 0.23 for pressure of	187
Brass on cast iron, 0.23 for pressure of	560

The lifting device must be so designed and fastened to the operating platform that a force can be exerted to close the gate as well as to open it.

The gate lifting devices can be classified according to the mechanical principle on which their action depends. They are represented by three general classes of machines: (1) the lever; (2) the inclined plane; (3) the cord or pulley. Each of these classes includes a number of different types of gate lifting devices. The following are most commonly used:

I. Lever class.
- a. Simple lever.
- b. Wheel and axle or windlass.
- c. Rack and pinion with operating arm.
- d. Rack with multiple gears and operating arm.

II. Inclined plane class.
- a. Threaded gate stem and operating wheel.
- b. Threaded gate stem, main geared wheel, worm and operating arm.

III. Pulley class.
- a. Simple pulley.
- b. Differential pulley.
- a. Gate stem, main bevel-geared wheel, bevel-geared pinion and operating arm.

IV. Lever combined with inclined plane or gearing.

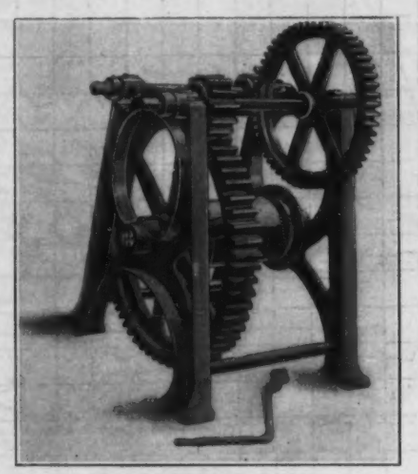
I. Lever class.

The **simple lever** requires that a frame be built to support a top horizontal piece near the face of the gate stem at a height of about 3 ft. from the floor. For a wooden structure this is usually done by extending the vertical posts which form the grooves of the gate, and placing a cap on top of the post. The force is applied to the gate stem by supporting the lever on a fulcrum. The fulcrum is preferably formed by bolting a metal bar to it. Two fulcrums are generally necessary; one to raise the gate and the other to force it shut.

A cheap form of lifting frame for a concrete structure is to imbed in the concrete vertical posts made of 1 or 2 in. wrought iron pipe extending about 3 ft. above the operating floor and connected at the top by means of elbows, to a horizontal piece of pipe which will serve for the fulcrums.

The gate stem, if of wood, is usually strengthened by a metal band, bolted to it, and with holes 2 in. apart into which one end of the lever is inserted. Necessary details for locking the gate in position must be provided. This type of lifting device is simple but is only applicable to smaller structures and where the required lifting force is not very great.

Wheel and axle or windlass. A windlass requires an axle to which the gate is connected by means of chains or ropes and an operating wheel or arm fastened to one end of the axle. It may be either a traveling winch which can be moved from one gate



Gate-Lifting Windlass.

to the next, or a stationary one. In the second case the axle is placed above the gate and may be used for more than one gate by extending it above the other gates; the gates may be lifted either together or singly.

The axle must be at a height of about 3 ft. above the operating platform. A simple frame to support the axle can be made of iron pipe. This will consist of two or more posts made of pipe with the lower end fastened to the operating platform or buttress walls and the upper ends threaded and extending about 3 ft. above the floor. Tees screwed on to the upper ends will form the bearings for the axle. The axle will be a smaller size pipe, which fits in the tees. The operating arm is connected by means of an elbow screwed to the threaded end of the axle.

The mechanical advantage is equal to the length of the operating arm divided by the radius of the axle. If

P = total pull necessary to lift the gate.
F = operating force.
r = radius of axle.
R = length of operating arm or radius of operating wheel;

then, $F = \frac{Pr}{R}$

This type of device is only used where the pressure on the gate is not very great, and where it is not necessary to exert a downward force to close the gate.

Rack and pinion with operating arm. This device consists of a rack fastened to the gate stem, a geared pinion to transmit the force to the rack and an operating wheel or arm connected to the same

Rack With Multiple Gear for Lifting Gate.

axle as the pinion. The force is applied to the operating wheel, the fulcrum is at the center of the wheel and pinion and the pull acts at the rack. If

P = total pull.
F = operating force.
R = length of operating arm.
n = number of gear teeth in pinion.
p = pitch of gear teeth on rack or pinion.

then, if the efficiency of the gears is e, the work equation is

$$npP = e \times F \times 2\pi R$$
$$\text{or } F = npP/2\pi Re$$

If r = diameter on pitch line of pinion, then $np = 2r$, and $F = Pr/Re$. The efficiency of spur gear with teeth cast is about 93 per cent and with teeth cut, 96 per cent. A rack and pionion lifting device is preferable to a windlass when it is necessary to force a gate down.

Rack with multiple gears and operating arm. This consists of the simple rack and pinion with additional gears to give greater mechanical advantage. For a triple geared rack the relation between the operating force and the total pull is obtained as follows:

Let F = operating force at end of operating arm.
F_1 = force exerted by first pinion on main geared wheel.
P = force exerted by second pinion on rack or total pull on gate.
R = length of operating arm.
r = radius of pinion connected to same axis as operating arm.
R_1 = radius of main geared wheel.
r_1 = radius of pinion acting on rack.
e = efficiency (93 per cent for cast teeth, 96 per cent for cut teeth).

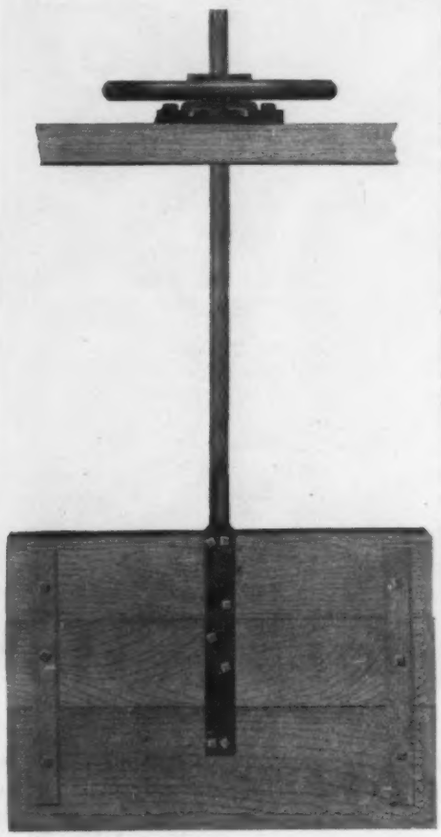
The work equations are:

$$F = \frac{F_1 r}{Re} \quad F_1 = \frac{Pr_1}{R_1 e} \quad F = \frac{Prr_1}{e^2 R R_1}$$

A multiple rack is used where it is desired to overcome a larger force than can be conveniently done with a simple rack; in which case it has no special advantage over a threaded gate stem and operating wheel which is usually less expensive.

II. Inclined plane class.

Threaded gate stem and operating wheel. This is the simplest device of this class. The lower end of the gate stem is connected to the gate and the upper end is threaded and screws in the operating wheel. The operating wheel is either supported on a beam above the gates or is part of the operating stand. When lifting the gate the wheel presses down



Threaded Gate Stem and Operating Wheel.

on the beam, but when lowering the gate unless its weight is sufficient to overcome the friction a force is exerted upwards on the beam and to force the gate shut the operating wheel must be either held down to the beam or a second wheel placed on the under side of the beam. The former arrangement is usually preferable for large gates. To decrease wear and friction the bearing surfaces are usually made

of different materials. A flanged nut of phosphor bronze with threads to match the threads of the gate stem, is inserted in the center of the operating wheel and keyed to it. The flange of the nut is on the under side of the gate and bears on a brass seat. A brass cover plate placed over the flange and bolted to the beam will hold the wheel down and form the seat for an upward force. To further decrease the friction ball bearings may be used.

Typical Design of Steel Gate.

The gate stem may be made from a solid steel axle or from heavy pipe. It must be designed not only for tension but for torsion and compression. The minimum diameter in practice is about 1 in. The number of threads per inch is generally 3 or 4. The size of the operating wheel will vary with the power desired. For one revolution of the wheel the gate is raised an amount equal to the pitch. The work equation is as follows:

Let P = total pull on gate.
p = pitch of threads.
R = radius of operating wheel
F = operating force.
e = efficiency of device. The efficiency, which is the combined efficiency of the screw and of the seat may be taken as about 25 per cent.

$$pP = e\,2\pi RF$$

$$F = \frac{pP}{e\,2\pi R}$$

Threaded gate stem, main geared wheel, worm and operating arm. This device is used where a more powerful machine is wanted. It consists of the threaded gate stem, the main geared wheel which has the same relation to the gate stem as the operating wheel described above, the worm or endless screw which acts on the gears of the wheel and an operating

Operating, Arm Worm, Main-geared Wheel, and Threaded Gate Stem Lifting Device.

arm connected to the worm. The machinery is generally assembled on a cast iron stand which can be bolted to the operating floor. One revolution of the arm gives a revolution to the worm which moves the main geared wheel through the pitch of the threads of the worm. The relation between the operating force and the total pull is given by the following equations:

p = pitch of threads on gate stem.
p_1 = pitch of threads on worm.
R_1 = radius of pitch line on main geared wheel.
R = Radius of operating arm.
P = total pull on gate.
F = operating force.
F_1 = force exerted between worm and geared wheel.
e_1 = efficiency of worm = about 50 per cent.
e_2 = efficiency of screw stem = about 25 per cent.

$$2\pi RFe_1 = F_1 p_1 \quad \ldots\ldots (1)$$

$$2\pi R_1 F_1 e_2 = Pp \quad \ldots\ldots (2)$$

From (2) $F_1 = \dfrac{Pp}{2\pi R_1 e_2}$ which substituted for F_1 in (1) gives $F = \dfrac{Pp\,p_1}{4\pi^2 R R_1 e_1 e_2}$

$$F = \frac{Pp\,p_1}{5\pi^2 R R_1} = \frac{2P\,p_1 p}{\pi^2 R R_1}$$

III. Pulley class.

A **simple pulley** lifting device would consist of one block fixed to the operating frame, built above the gate, a second block fixed to the gate, and the connecting ropes. The blocks may have single sheaves or multiple sheaves which revolve independently. As there are two ropes to each sheave, the operating force will equal to the total pull on gate divided by two times the number of sheaves.

Let F = operating force.
P = total pull on gate.
n = number of sheaves in each block.

$$\text{then } F = \frac{P}{2n}$$

Simple pulleys are seldom used. Their mechanical advantage is small so that they can only be used for small gates under low heads.

A **differential pulley** device would be similar to simple pulley device except that the upper pulley is a block made of two sheaves of different radii, fixed

Stand for Operating Wheel and Threaded Gate Stem Lifting Device.

to each other so as to rotate as one piece about a fixed axis. The lower pulley is a single sheave block whose radius is a mean of the radii of the upper pulley.

Stand for Bevel-Geared Lighting Device.

The rims of the pulleys are shaped to hold an endless chain which passes over the three sheaves.

Let R = radius of larger sheave of upper pulley.
r = radius of smaller sheave of upper pulley.

$$R_1 = \text{radius of sheave of lower pulley} = \frac{R + r}{2}$$

F = lifting force.
P = total pull on gate.

$$\text{Then } F 2\pi R = P\,(2\pi R_1 - 2\pi r)$$

$$FR = P\,(R_1 - r)$$

$$\text{or } FR = P\left(\frac{R + r\,2r}{2}\right) = \frac{P}{2}(R - r)$$

$$F = \frac{P}{2R}(R - r)$$

IV. Combined lever and inclined plane or gearing.

The device of this class used generally consists of the gate stem, a horizontal main bevel-geared wheel, a vertical bevel-geared pinion and an operating arm or wheel connected to the pinion. The machinery is generally assembled on a cast iron operating stand. The gears are of steel and the bearings for the gate stem and main geared wheel are made as for the simple gate stem and operating wheel device described above.

Let R = radius of operating wheel or length of operating arm.
r = radius of pitch line of pinion.
R_1 = radius of pitch line of main bevel-geared wheel.
p = pitch of threads on gate stem.
F = operating force.
F_1 = force exerted between geared wheels.
P = total pull on gate.
e_1 = efficiency of bevel gears: 92 per cent for cut teeth; 96 per cent for cast teeth.
e_2 = efficiency of screw stem: about 25 per cent.

$$\text{Then, } e_1 2\pi RF = 2\pi r F_1 \quad \ldots\ldots (1)$$

$$e_2 2\pi R_1 F_1 = p P \quad \ldots\ldots (2)$$

$$\text{From (2) } F_1 = \frac{p P}{e_2 2\pi R_1} \quad \ldots\ldots (3)$$

Substitute (3) in (1)

$$e_1 2\pi RF = \frac{2\pi r p P}{e_2 2\pi R_1}$$

$$\text{or } F = \frac{p P r}{e_2 e_1 2\pi R R_1}$$

INTERESTING FACTS ABOUT CHILE.

Chile, which on the map appears to be 2000 miles long and about 2 inches broad, extends from 7° 47′ southward to Cape Horn, and measures more than 2500 miles in length, while the breadth of the territory from the Andes to the Pacific varies from 100 to 180 miles.

The real wealth of Chile depends, of course, on her rich soil, valuable climate and the vigor and industry of her proletariat (working people). But though there is a considerable export in agricultural produce, and although the government seems fully to realize that agriculture and colonization must be encouraged and carefully fostered by every means, yet it is to the nitrates and mining products that the present wealth of Chile is due. It is the export duty on nitrates that keeps Chile prosperous and flourishing.

There is no opportunity in Chile for the British workman. No European could compete in manual labor with the frugal Chileno. But a master-workman with a little capital, or indeed, any man with business enterprise, thorough knowledge of his profession, and from $1000 to $4000, ought to find his opportunity. Certainly the chances are infinitely more favorable than any which he is likely to obtain at home. But he should work for some one else in Chile for at least two years before launching out on his own account.

PURIFICATION OF GAS.[1]

BY E. C. JONES.

This subject is intended to cover the treatment of coal gas from the hydraulic main to the station meter, and includes condensation, scrubbing and washing, as well as what is strictly termed purification.

The temperature of the retort in which coal is distilled is usually above 2000 degrees F., and the temperature of the gas only a few feet away from the retort is 125 degrees F. Five cubic feet of purified gas at normal temperature has a volume equal to about 390 times that of the pound of coal from which it was made. This gas as it leaves the retort in a crude state, is expanded in volume by the vapors of gas liquor and tar, as well as the other impurities removable by purification. The crude gas is also in an expanded condition on account of its temperature above normal. This amounts to 13.2 per cent of its volume for expansion between 60 degrees F. normal and 125 degrees F. its temperature before entering the hydraulic main.

Gas is expanded by heat 1/491.4 for each degree, or about 1 per cent for every five degrees F.

Nothing but coke remains in the retorts, so that the hot gas leaving the retort contains all the tar and ammoniacal liquor distilled from the coal and held in suspension in the form of fog and vapor. The amount of these substances so held depends on the heat of the gas, so that when the gas enters the hydraulic main there is a considerable drop in temperature and the heavier portion of the tar and ammoniacal liquor is deposited in the hydraulic main, and in turn flows to the tar well. The piece of apparatus next in sequence to the hydraulic main is the exhauster. This machine is best explained by calling it a rotary gas pump, and it performs the double duty of drawing the gas from the hydraulic main, (and it is from this work that it received the name exhauster) relieving the back pressure on the retorts, and at the same time exerts pressure at the outlet to force the gas through the condensers, scrubbers, and purifiers.

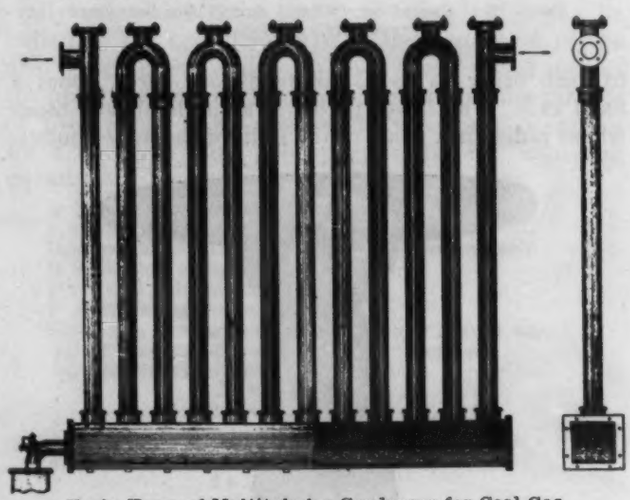
It is difficult and quite unsatisfactory to attempt to describe by words the construction of even simple machinery, and reference to diagrams and models will give a much better understanding of gas works apparatus.

The first rotary exhauster was invented by Beale in England, and it was afterwards much improved by P. W. Mackenzie of New York. The Roots exhauster is probably most generally used in gas works of today. This machine consists of two impellers shaped like the figure 8. These are set on parallel shafts at a pitch of 90 degrees, so that one swings within the other, and are enclosed in an iron case with inlet and outlet pipes on opposite sides.

Exhausters are usually operated by steam engines, either direct connected or belt driven. In many gas works the exhauster is located beyond the condenser, but when it is so placed it requires so much lubrication that it became a source of trouble. When it is placed between the hydraulic main and the condenser it requires no internal lublication, and if allowance is made in the construction of the exhauster for expansion, due to pumping hot gas, it works most satisfactorily. The exhauster at this point also performs a certain amount of mechanical scrubbing by breaking up and depositing tar globules. Another and perhaps the best reason for placing the exhauster immediately after the hydraulic main is that all condensing and scrubbing apparatus is operated under pressure. Experience teaches that it is better that gas shall leak out of such apparatus than to have air drawn in.

The function of the gas condenser is to gradually, and without shock, reduce the temperature of gas to nearly the local normal temperature of the air. In thinking of gas it must not be considered as a fixed chemical substance, but as a physical mixture of gases of different densities. At the hydraulic main every part of the coal, excepting the coke, is in the form of gas heavily charged with water and hydrocarbon vapor. Some of these vapors are deposited in the hydraulic main; and the foul main encircling the retort house, and more of them in the condenser, and the amount of volatile hydrocarbon deposited or remaining in the gas is simply a question of vapor tension due to temperature.

The vapor tension increases with a rise of temperature and decreases with a fall of temperature. The treatment of the gas in the condenser and scrubber should therefore be such that the gas will become stable, and retain its illuminants at local normal temperature. This differs with the seasons of the year and at different latitudes.



Early Form of Multitubular Condenser for Coal Gas.

The simplest and first form of condenser was a series of upright, round pipes, fitted into a cast iron base and connected at the top by return bends. The base contained partitions extending nearly to the bottom, between each pair of upright pipes. This provided a great length of condensing tubes in a small space, and the condensed tar and ammoniacal liquor flowed downward on the inside surface of the upright pipes into the base and thence to the tar well. Condensation in this apparatus is accomplished by the radiation of heat through the pipes, and is assisted by the frictional scrubbing of the gas on the inside

[1] A lecture delivered before the students in the new Gas Engineering course at the University of California.

surface of the pipes and in changing its direction of flow through the condenser.

Clegg claimed that "when ordinary vertical iron pipes, radiating in air are used, the portion of the gas in the center is not brought into contact with the exterior and cannot be effectively cooled." Many new forms of apparatus have grown out of this simple multi-tubular condenser, some vertical and some horizontal, while others increase the frictional area and length of passage by using flat sinuous tubes in place of round pipes.

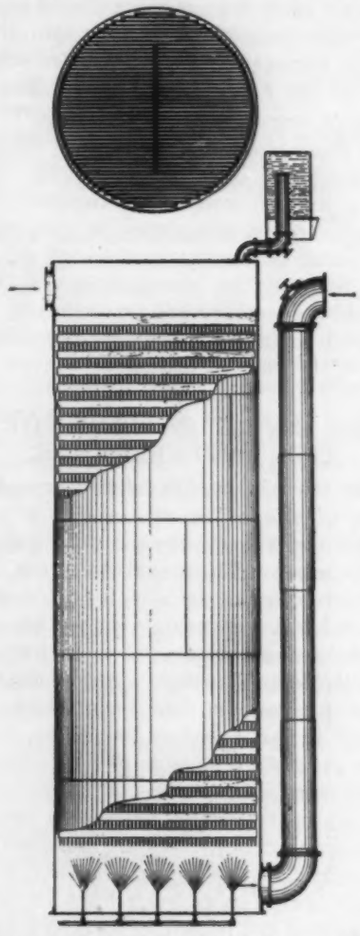
Another type of condenser consisted of a series of large upright pipes, one within the other. This was known as the annular condenser. The inner tubes were open to the air at both ends, while the outer tubes were connected together at the top and bottom in regular sequence. The gas passed through the annular space between the pipes and a current of air was drawn through the inner pipes. These condensers were usually made of wrought iron, on account of the comparatively thin walls of the pipes there was a greater radiation of heat. In warm weather it often became necessary to have a spray of water in the inner tubes to assist in the cooling of the gas.

These types of condensers were easily clogged by stoppages of thick tar and pitch, and it was difficult to clean them. All condensers depending on air radiation to reduce the temperature of the gas, are subject to climatic changes hourly, daily, and seasonally, without means of regulation. The condenser now generally used as a primary condenser in coal gas works, is an upright steel shell cylindrical in form, and containing a large number of boiler tubes, expanded into tube sheets placed near the top and bottom of the outer shell. The gas inlet is at the side above the upper tube sheet, and the outlet is at the side below the lower tube sheet. In this form of condenser the gas flows through the tubes, and the space around the tubes is filled with water. To avoid sudden cooling of the gas, the water inlet is at the bottom where the gas is at its lowest temperature, and the water outlet is at the top, so that the heated water comes in contact with the tubes where the gas is hottest. With a condenser of this type of ample capacity, the temperature of the gas may be gradually reduced, and any variations in volume of gas, or changes in atmospheric heat, may be compensated for by regulating the flow of water around the tubes.

Condensation removes the tar fog, tar vapor, and ammoniacal liquor held in suspension; and these flow together from the base of the condenser, through a sealed drip-pot to the tar separator, where owing to the difference between the specific gravity of tar and ammoniacal liquor there is a separation and each flows to its own storage well.

In modern coal gas works, what is known as a foul main receives the gas from the hydraulic main and conveys it to the exhauster. This is usually a large sheet steel pipe suspended to the walls of the retort house, and acts as a condenser and at the same time some of the naphthalene in the gas is absorbed by passing over the condensed tar. In some works a simple tar scrubber either takes the place of the foul main, or is supplementary to it. The tar scrubber removes a portion of the naphthalene, and the tar gives up some of its benzol to the gas, adding somewhat to its candle power. After the condensers, it is customary to pass the gas through a tower scrubber for the purpose of removing any tar remaining in it, and for the extraction of ammonia by water scrubbing.

The first tower scrubbers were filled with gas coke in deep layers resting on wooden trays. This material was taken from stock always at hand, and proved efficacious as a filtering material. It had the troublesome disadvantage of becoming clogged with tar and causing back pressure. This required frequent changing and it often happened at inopportune times. The coke after being used in the scrubber was again used as boiler fuel. Probably the best



Modern Scrubber for Coal, Water or Oil Gas.

form of scrubber is an upright steel shell filled with wooden trays, or grids, made by spacing boards on edge in sections which completely fill the shell; each section being placed at right angles to the one immediately above and below it. Water is sprayed over these trays at the top, and flows downward through the trays and overflows at the bottom into a sealed drip-pot. The gas inlet is at the bottom below the trays, and the gas outlet is at the top above the trays. In this manner a large area of wet surface is presented to the gas with a minimum use

of water. The ammonia in the gas, which is not condensed as gas liquor in the hydraulic main and condensers, is removed by water in the scrubber and washers, and the temperature of the gas is still further reduced. To completely remove ammonia by absorption by water, it is necessary to reduce the temperature of the gas to 60 degrees F.

The scrubber water flows to the ammoniacal liquor well, and as this liquor is a valuable by-product great care is used in saving it, and it is then pumped back to the scrubber and is used over and over until it has reached a marketable strength.

The final treatment of the gas for the removal of ammonia is by passing the gas through a rotary washer, consisting of a number of circular discs fastened to a revolving shaft in a cast iron case. These discs are made of thin sheets of iron spaced about ⅛ in. apart; and each disc revolves in a separate compartment. Gas enters the washer at one end, and after passing between the sheets of iron in the discs, passes out at the other end. These discs are sometimes made of wood. The compartments are so arranged that there is a different water level in each one, this is accomplished by having a slightly lower overflow opening in each succeeding compartment. Fresh water is admitted to the upper or gas outlet end of the washer, and flows slowly through to the lowest overflow, filling all the compartments. These discs revolving in the water are constantly presenting freshly wetted surfaces to the passage of the gas.

(To be continued.)

PROPOSED INVESTIGATIONS FOR INDUCTIVE INTERFERENCE.

Early in the official life of the present Railroad Commission of the State of California many cases of inductive interference between the power lines and the lines of communication systems were brought up for official settlement. It was found that comparatively little is known accurately as to the quantitative effect of different factors on the disturbances in communication circuits, although a great deal of theory of induction phenomena has been worked out. It was felt that if the question could be discussed at length some valuable results might be obtained which would assist the commission in determining under what conditions parallels between high tension power lines and communication lines are permissible, and in issuing regulations governing thereafter the construction and operation of such lines in proximity to each other, so that the inductive interferences common to such parallelism could be minimized. Accordingly the Railroad Commission early in December, 1912, invited companies owning and operating electric power lines and telephone and telegraph lines in the State of California to meet informally and discuss the question of appointing committees representative of the many interests concerned, to form an organized investigating board, which, together with representatives of the commission, should constitute a joint committee empowered by the Railroad Commission to conduct tests and experiments, the results of which should serve as a basis for future regulations of the commission.

The conference met December 16, 1912. Four representatives were selected by the power interests, four by the communication interests, one by the railroad interests, and four were appointed by the commission. At a subsequent meeting the joint committee was increased by the selection of one more representative of the power interests and one of the communication interests, making a total of fifteen. The committee organized under the name of The Joint Committee on Inductive Interference by the election of a chairman, a secretary and a treasurer, and by the appointment of sub-committees on ways and means, finance, transportation, program, and publicity, as permanent committees, and by the appointment of a committee to supervise and to analyze the results of tests.

Assistance from the power, telegraph, and telephone companies in the shape of money contributions and from the railway companies in the shape of transportation for men and apparatus was requested. All of the companies interested in the work were requested to assist by furnishing such men and apparatus as might be available for the work, and by permitting the committee to use the communication and power lines for tests to be made at such times that they would not interefere with the public service. All parties concerned in the investigation have joined in the most liberal manner to meet these requests.

Already some work had been done by the Pacific Telephone & Telegraph Company and the Coast Counties Gas & Electric Company in an investigation of a parallel in Santa Clara Valley. A sub-committee was appointed to complete the work on this parallel, and their jurisdiction was extended over the second proposed series of tests at Salinas.

Since one of the reports of the test committee outlines essentially the method used in making both the first and the second series of tests, the folowing extracts are quoted from it:

Method of Making Tests.

In the following paragraphs are outlined the tests which are to be made on the communication circuits and power circuits for each condition of the power line.

A—Tests on Telephone Circuits:

The tests on telephone circuits are designed to give quantitative information regarding the total effect of the power lines on the telephone circuits and also regarding the effect of each harmonic in the power system on the telephone circuits.

The tests which are outlined here are those which past experience indicates will most efficiently and completely give the information required.

Preliminary Work:

During the tests all of the circuits on the telephone pole lead will be disconnected from the rest of the telephone system at each end of the exposure in order to obtain definite testing conditions and to avoid the effects of secondary induction from other parallels in the system. As this procedure completely interrupts service over the telephone lead, it will ordinarily be necessary to make the tests at night. Good grounds will be made at the test poles at each end of the exposed section of the telephone line. Two pairs of

wires well insulated and well transposed will be run from the station where the tests are to be made to the telephone pole line.

Condition Tests:

Two telephone lines will ordinarily be connected in for test at the same time, and where possible these two circuits will be side circuits of a phantom so that these tests may be made at once on two physical circuits and one phantom circuit. The tests will be made on a sufficiently large number of telephone circuits to ensure that an idea has been obtained of the extreme and average conditions of the lead. The tests are briefly outlined below:

1. Tests of the capacity and insulation balance of each telephone circuit.

2. Tests of the total noise induced in the telephone circuits.

3. Tests of the current flowing between the telephone wires and ground on short circuit and of the voltage induced between telephone lines and ground on open circuit.

4. Observations of the voltage from each power line to ground and also of the residual voltage, that is, the vector sum of these three voltages. Observations also of the current in each line wire and of the residual current, that is, the vector sum of these three currents.

5. Resonance analyses of the induction between telephone wires and from telephone wires to ground, and of the above named voltages and currents in the power system.

6. Oscillograms of the voltages and currents in the power and telephone systems mentioned in Item 5.

B—Tests on Telegraph Circuits:

Arrangements will be made by which all of the telegraph circuits on the telegraph line may be opened at the same time for short periods during which tests are being made in order to obtain definite testing conditions, and to eliminate the effect of secondary induction. Arrangements will also be made so that the telegraph wires may be looped one at a time into the stations where the tests are being made.

Tests will then be made on each telegraph wire of the voltage to ground with both ends open circuited and with the distance end connected to ground, and of the current flowing through the circuit with both ends connected to ground. A sufficient number of oscillograms should be taken to determine the wave shapes of the induced disturbance under different conditions.

These tests will be carried out on a sufficiently large number of telegraph wires to determine to what extent the disturbance is different for circuits on different pin positions of the telegraph lead.

Simultaneously with the above tests observations will be made of the voltages and currents in the power line as outlined in paragraphs 4, 5 and 6 under "Tests on Telephone Circuits." These observations need, however, include only the magnitudes of the fundamental and of the one or two most prominent harmonics.

C—Tests on Railroad Signaling Circuits:

Observations and oscillograms will be made of the maximum alternating current induced in the railroad signalling circuits under different conditions.

D—Miscellaneous Tests:

It may be found desirable to make further tests on some other types of equipment, such as the telegraphone or of the other types of circuit which are not considered above.

Conditions of the Power Circuits.

The following is a general outline of the different conditions of the power circuits under which tests should be made. In this outline no attempt has been made to go into detail as it is felt that the detailed tests will be modified according to the exigencies of operation and that additional tests will be suggested by the results of the tests here outlined:

1. Tests with the power line cut dead, to determine that under these conditions the signalling circuits are free from disturbances.

2. Tests of the inductive disturbance under normal operating conditions, both light and heavy load.

3. Tests of the effect of different transformer connections on the induction in signalling circuits.

4. Tests of the effect of grounding and opening the neutrals of star connected transformers.

5. Tests of the effect of operation of relief and emergency steam stations.

6. Tests of the effect of charging aluminum lightning arresters.

7. Tests of the effect of switching high tension lines.

8. Tests of the disturbance caused by known residual voltages and currents. In these tests the conductors of the power line involved in a given parallel will be cut dead and a known voltage will be impressed between the three power wires in parallel and the ground. Tests of the effect of unbalanced current will be made by passing a known current through each of the line wires with a ground return.

9. Tests with one line wire grounded. In these tests the method of procedure will probably be to create a ground on one wire when the line is dead and then to switch potential on the circuit.

The sub-committee on Program is analyzing information now being sent in by the communication and railroad companies concerning parallels with which they are now experiencing difficulty and information which the power companies are sending in regarding their systems. With this information it will report recommendations for future tests.

It is hoped that within a year or two valuable results will be obtained which may serve as the basis of recommendations to the Railroad Commission.

It is the intention of the joint committee through the sub-committee on publicity to furnish to the technical press from time to time such information as may indicate to the engineering public and to the corporations concerned the nature of the work being undertaken and the results obtained up to the date of publication of the report in so far as these results can be considered to be final.

The object of making such application is for the information of the interested companies and of the engineers of the country, with the expectation that they will show an interest in the work now being done in California by such constructive criticisms and suggestions as will further the work of the joint committee on inductive interference and that in the end all sections of the country may profit by the results of their labors.

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The Pump and the Reservoir

A short seasonal rainfall makes the farmer's fancy turn toward possible means of artificial irrigation. Likewise the energetic power salesman is not indifferent to the psychological effects ensuing, namely, an opportunity to spike a new consumer for his company.

The present month is undoubtedly witnessing the most heated campaign ever experienced in the West in the installation of electrically operated pumps. Thousands of new pumping loads are soon to exert their influence upon the central station meters. The rates as a whole which have been instituted in the rural communities by the central stations are satisfactory. They will enable the farmer to send a better product upon the market and in larger quantities per acre, thus ensuring him a greater net return per acre through the utilization of electric power.

There are, however, many additional points that might well be borne in mind both by the farmer consuming the electrical energy and by the central station furnishing the supply. In many instances the farmer has been urged by the over-zealous power salesman to install a pumping outfit of such proportions that he will scarcely utilize his minimum guaranteed consumption during the irrigation season and thus be unable to take advantage of the attractive sliding scale of rates offered by the central station. Such a procedure as this, while temporarily inflating the boasted connected load of the central station, aids little in a broad policy of educating the farmer in the economic use of electrical energy. Only by means of the power salesman's being able to win the confidence of his justly suspicious consumer can the ultimate universal triumph of electrical energy-consuming devices upon the farm be attained.

Thus, the power salesman who sees upon a farm, from its natural topographic configuration, the possibilities of economically storing water and fails to impress this economic law upon his client will some day awaken to the fact that co-operation on the farm is an impossibility. In those communities where the agriculturist has been encouraged to store water and thus enable him to operate his plant upon a hundred per cent power factor while at his convenience he is enabled to irrigate with a proper head of water from the reservoir, electrical consumption is by far the more advanced.

Such practice has the advantage, too, not only of making it possible to irrigate other lands thought to be beyond the economic range of the electrically-operated pump, but it materially aids in maintaining a better load-factor throughout the hydroelectric network. The rapid growth of the electrical industry has indelibly exposed one glaring fallacy to the engineering world, namely that a decreased consumption of electrical energy per unit of accomplishment decreases the sales output accordingly. Such a fallacy

was long feared, but the advent of the tungsten lamp wherein candlepower per kilowatt of electrical energy is vastly heightened, has unmistakably resulted in increasing the electrical consumption in every American home by opening new and broader fields of electrical application.

And so it must be upon the farm. In every case wherein the farmer is enabled to utilize electrical energy according to the most economic law, the central station will reap a correspondingly enlarged field of electrical consumption. The small farm reservoir, then, enabling the farmer to take advantage of the cheapest rates, should be encouraged by the central station, whenever such practice is reasonably feasible.

Apprenticeship Systems for Utility Service

The increasing popularity for agricultural professional training throughout the West and for mechanical and electrical engineering endeavor along these lines are already having their effect in limiting the number of young men who desire to prepare themselves for a central station engineering career. The public utility fraternity may well seriously consider the inauguration of some apprentice system of training which will prove an attractive and profitable experience for those who some day are to be the nucleus for operation, maintenance and engineering skill of the public utility regime.

The personnel of a works is of a scarcely less importance to its success than the quality of the plant and machinery. Indeed, Western experience would strongly indicate that more has been accomplished by a loyal, enthusiastic well-trained corps of workers than by any other factor. Witness for example the industries and utilities of the West, in some instances, swept from the face of the earth by fire and yet today these self-same industries and utilities, buoyed up by the tireless effort and loyalty of its personnel, have overcome every obstacle. The work being accomplished by the great hydroelectric corporations of the Northwest and Southern California, too, amply demonstrate the efficiency of men and not matter. Hence the problem of educating and preparing suitable men to carry on this work is one of much importance. Though Western conditions are vitally different from those in the East, or in Great Britain, still some ideas may be gleaned from the practice of our older brothers. Thus, Eastern apprenticeships are naturally segregated into three main classes. The first class consists of boys of not less than 15 years of age who desire to become artisans or "tradesmen" on reaching the age of twenty-one. They must produce proofs of having had a satisfactory elementary education and must attend evening schools of technology during their years of apprenticeship. Young men not under 17 years of age of good general education and of recognized technical training may constitute a second class. This class is for youths who desire practical training in different branches of engineering. Throughout their apprenticeship they are transferred from department to department so as to obtain as wide an experience as possible. Such men must continue their technical education at an approved technical school, or at the university, special permission being granted for necessary absence from duty. The third class constitute young men not less than 20 years of age who desire to acquire a practical workshop training. They must have passed through a complete course of technical training, or obtained an engineering or science degree at the university. Great importance is attached to the educational qualifications that the candidate is able to submit. A written agreement is entered into for a definite period, and although the firm does not guarantee that men in this class shall spend a specific time in any particular department, the management as far as is possible, however, selects such departments as is most suitable to the attainments and capabilities of each man.

It would seem that, since the day of first things has now passed in Western utility development, the time is ripe for earnest consideration of the utility apprenticeship. Hitherto fate or chance happening has largely determined the preparation of men supposed to be technically qualified for Western utility work. The new order of things, built upon a more substantial and permanent basis requires men of highly specialized training. Particularly should the future executives, division managers and operating engineers be thoroughly trained for their duties. The great metropolitan districts of the West are now well equipped with technical schools. Men for class number one might well be prepared by educational and welfare work among the rank and file similar to that instituted by the New York Edison Company. It is surprising to what heights efficiency may thus be engendered.

Fortunate is the utility company that develops throughout its mass of employes, a whole-hearted love and loyalty to the utility regime. Many Western companies today possess this god-given attribute pervading the working classes. Deep consideration should be had by the present executives of these utility companies in evolving methods to perpetuate such a race of men, for, as said Goldsmith in the Deserted Village,

> "Kings may come and kings may go,
> But a bold peasantry once destroyed can never be replaced."

Preparation of future lieutenants and captains of utility service on the other hand, should be undertaken as outlined in classes two and three. How vastly more practical and of what real service would our Western technical schools thus become if their theoretical technical training were made to synchronize somewhat so as to aid in apprenticeship courses as given in the latter two classes. Neither the utility company nor the apprentice need be under obligation one to the other. A plain survival of the fittest should pick the future leaders. Thus will utility service be immeasurably heightened and technical training be most effectual.

PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLICITED FROM ALL READERS

H. E. Sanderson, Pacific Coast manager for the Bryant Electric Company, is at Seattle.

K. G. Dunn, of Hunt, Mirk & Company, is expected to return from a six weeks' Eastern trip about April 1st.

Harry Kirkland, of the American Conduit Manufacturing Company, left the first part of the week for Portland.

H. B. Squires, manufacturer's agent at San Francisco, is making a brief trip throughout the Pacific Northwest.

Frank Quinn, of the Manhattan Electrical Supply Company, is making a two weeks' trip through the Pacific Northwest.

J. A. Herr, sales engineer with Sprague Electric Company, is visiting the towns of the San Joaquin Valley, California.

J. C. Bird, local manager of the Kendrick Electric Company, Tacoma, spent two days in Portland recently on personal business.

F. N. Boyer, assistant manager of the Chicago office of the General Electric Company, and Mrs. Boyer, are on a trip through California.

John S. Stone, a consulting electrical engineer of Boston, is at San Francisco in the interest of several prospective exhibitors at the Panama-Pacific Exposition.

E. M. Cutting has been appointed manager of the California District of the Edison Storage Battery Supply Company, with headquarters at 818 Mission street, San Francisco.

Miles Steel, sales engineer with the Benjamin Electric Company, returned to San Francisco this week from Southern California and left later in the week for Portland and Seattle.

W. S. Hanbridge, secretary of the California Electrical Contractors' Association, has just completed a trip throughout the various California towns in the interests of his association.

Frederick Pratt, president of the Stone & Webster Corporation, Boston, visited in the northwest for some time recently, looking over various properties in Seattle, Tacoma and Bellingham.

H. E. Sherman recently resigned his position with the Oakland, Cal., office of the Great Western Power Company to rejoin the San Francisco sales force of the Crocker-Wheeler Company.

Frederick G. Simpson, chief engineer and general manager of the Kilbourne & Clark Manufacturing Company, Seattle, has gone east with a view to purchasing machinery for the plant being erected.

W. W. S. Butler, vice-president and general manager of the Western States Gas & Electric Company, at Stockton, was at San Francisco during a hearing of the California Railroad Commission this week.

C. E. McFarland, formerly vice-president and general manager Nebraska Telephone Company, has succeeded **C. C. Bradley,** who recently resigned a similar position with the Pacific Telephone & Telegraph Company.

Garnett Young, manager of the Telephone-Electric Equipment Company, announces the opening of a sales office at Portland in charge of **Fred H. Smith,** formerly with the Seattle branch, of which **F. G. Larkin** continues as manager.

Llewellyn Evans and **E. H. Little** of the Evans-Dickson Company, Tacoma, spent several days recently in Port Townsend in connection with work on the lighting system and pole line which the company is installing at Fort Casey, Washington.

R. E. Gorton, general manager of the Packard Lamp Company at Warner, Ohio, is at San Francisco with Mrs. Gorton. He is making his headquarters with the Electric Appliance Company, who are the Pacific Coast distributors for Packard lamps.

MEETING NOTICES.

San Francisco Section A. I. E. E.

Following is the schedule of meetings for the San Francisco Section of the American Institute of Electrical Engineers:

February 28—"Operation of Transmission Systems," by Lee Hagood.

March 28—"Description of An Inventory and Valuation of a Gas and Electric Plant," by H. W. Crozier.

April 25—"Electrically Operated Drawbridges," by G. W. Welch.

May 23—"Multiplex Telegraph and Telephone Circuits," by W. R. Birt.

June 27—"Economies of Production and Use of Electric Power," by C. L. Cory.

The meetings of the Section are held Friday at 8 p. m. in Native Sons' Hall, 430 Mason street. All electrical men are invited to attend.

Spokane Section, A. I. E. E.

A preliminary meeting to arrange for the formation of the Spokane Section of the A. I. E. E. was held on March 3d. Mr. John B. Fisken was elected temporary chairman, and H. B. Peirce, secretary. A committee on by-laws was appointed to report at the next meeting when permanent officers will be elected. At that time Mr. D. F. Henderson will give an address on the benefits to be derived from a local section.

Portland Section, A. I. E. E.

The next regular meeting of the Portland Section of the A. I. E. E. will be held at 8:15 p.m. in the club rooms of the Oregon Technical Club, 247½ Stark street, March 18th. A paper will be presented by Mr. O. C. Brill, district plant engineer for the Pacific Telephone & Telegraph Company in Portland, Oregon, on "Long Distance Telephone Transmission on the Pacific Coast."

Portland Section, A. S. C. E.

The Portland Chapter of the American Society of Civil Engineers held an informal dinner at the Portland Commercial Club, Thursday evening, March 13, 1913. Major J. J. Morrow, Corps of Engineers, U. S. A., talked on "Railroad Development of Alaska." Major Morrow is chairman of the board appointed by the president of the United States to investigate railroad conditions in Alaska and his preliminary report to the local chapter was of intense interest.

Portland Jovian Lunch Club.

The regular Thursday lunch club of the Portland Jovian Lunch Club, met at noon in their new quarters in a private dining room adjoining the grill of the new Oregon Hotel Annex, about 50 members attending. Mr. C. P. Osborne presided as vice-chairman and Mr. C. F. Swigert gave a "talk" on his experiences in connection with the early generation of electric power in Portland twenty-three years ago.

Tacoma Jovian Luncheon Club.

The Tacoma Jovian Luncheon Club was recently reorganized and is holding its luncheons every second and fourth Tuesdays at the Olympus Cafe. The luncheons are handled by an entertainment committee and it is the intention to have a speaker or speakers appear at each luncheon for the discussion of subjects in which all are interested. Officers of the club are: K. C. Schluss, Statesman and Chairman; E. H. Little, Secretary, and P. L. Hoadley, Treasurer.

Seattle Jovian League.

The regular weekly luncheon of the Seattle Jovian League was held at the Rathskeller Friday noon, March 7. About 40 Jovians attended. C. F. Terrell of the Puget Sound Traction, Light & Power Company, gave a talk and demon-

strated the working of the pulmoter in its application to resuscitation from electric shock. Much interest was manifested and a good program was carried through. The Jovian League of Seattle has decided that instead of holding its usual spring rejuvenation it will wait until the holding of the Northwest Light & Power Convention in the fall. One evening during that week will be turned over to the Sons of Jove. The applicants will be gathered and under the circumstances the best of results are expected. C. M. Bliven is Chairman of the League, Burton R. Stare, Statesman, and R. G. Barton, Secretary. Interest in the work has greatly increased during the past four months and the attendance at the weekly luncheons has steadily grown.

Oregon Technical Club.

The regular Tuesday luncheon, on March 4th in dining room "B" of the Portland Commercial Club, was attended by 62 members and their guests. W. G. Holford was chairman and Mr. F. H. Whitfield was the speaker of the day. His subject "Dreams for Dreamers" was very original and chosen by him to convey the speakers' idea of what should be the ideals of the Oregon Technical Club. The argument he presented to his audience was the argument that engineers must use their imagination before they commence to work out any material project; that is, they must figuratively "dream" first—then create their "dreams" into realities; therefore, he warned the Oregon Technical Club to be sure their "dreams" were never small and selfish, because they would surely react and no good could possibly come from some. Also, be careful not to choose "disastrous dreams" and wreck our organization, which as now organized was sure to produce many of its "dreams" into "Practical Realities," which would work a lasting benefit for the Commonwealth of Oregon.

ELECTRICAL DEVELOPMENT AND JOVIAN LEAGUE.

The regular monthly business meeting of the League was held last Tuesday. After completion of the routine business the report of the Golden Poppy Special No. 2 Committee, which showed much progress and an active interest in same on the part of the electrical men of the West, was approved. Over fifty have already signified their intention of attending the N. E. L. A. convention and joining the special train party leaving San Francisco the last week of May.

The speaker of the day was A. H. Griswold, plant manager of the telephone company, who told of "Some of the Fundamental Principles in Telephone Plant Construction."

REJUVENATION TO BE HELD AT SACRAMENTO.

Arrangements are being rapidly perfected for a Rejuvenation of the Jovian Order at Sacramento, California on the evening of March 29th. On March 8th a number of live wires met at lunch at the Hotel Sacramento and after listening to talks by Arthur E. Rowe, special plenipotentiary, A. E. Dundell, Jupiter of the San Francisco degree team, and Arthur H. Halloran, Statesman for Northern California, selected a membership committee consisting of C. V. Schneider, chairman, and C. R. Gill, secretary-treasurer. Arthur F. Peck has charge of the arrangements for a meeting place. Others active in the work at Sacramento are G. B. Baldwin, G. S. Pierce. R. C. Eyerly, H. R. Wilbur, C. H. Middlemas, J. C. Love, J. A. Woods and Douglas Jones. It is believed that a class of fifty will be admitted to the order at this time.

The degree team and Jovians from the San Francisco bay cities will go to Sacramento by boat on Friday night, March 28th, arriving Saturday morning. The day will be spent in Sacramento, the rejuvenation will take place at night and the return will be made on Sunday. Many of the members will take their families and every provision will be made for the entertainment and comfort of the ladies.

LECTURES ON GAS ENGINEERING.

The following lectures are to be delivered at the University of California by E. C. Jones, the well known gas expert. The public is invited to attend any or all of this interesting series:

February 17, 1913—The Manufacture of Coal Gas.
March 3, 1913—Purification of Coal Gas.
March 17, 1913—The Manufacture of Water Gas.
March 24, 1913—(Visit of the class to Potrero Gas Works).
March 31, 1913—The Manufacture of Oil Gas.
April 14, 1913—Distribution of Gas.
April 28, 1913—Measurement of Gas.

TRADE NOTES.

The Home Electric Company, Tacoma, has discontinued its retail store and is doing a strictly jobbing business.

The Pacific Light & Power Corporation of Los Angeles placed a large order for underground cable with the Safety Insulated Wire & Cable Company, this week.

The Grays Harbor Lumber Company at Hoquiam, Washington, will install a 500 kw. turbine with switch, 10 kw. generator and 7 kw. turbine exciter. The General Electric Company supplied these facilities.

A. L. Meyers & Company have recently moved to larger quarters at 111 New Montgomery street, San Francisco, where they are prepared to furnish Connecticut telephones, Bonnell adapter boxes, Canfield tape, Lux tungsten lamps and Knowles loom.

Mr. Hemple of the Alaska Light & Telephone Company, Valdez, was in Seattle recently, where he closed a contract with the General Electric Company for a 250 kw. generator for direct connection to a Pelton water wheel with switchboard, etc.

The General Electric Company gives notice of the sale to the Oro Electric Corporation, San Francisco, Cal., at Stockton, Cal., of a 1000 kw. Curtis turbo-generator with 10 kw. turbo-exciter and 14 kw. generator, Tirrill regulator, 20 h.p. motor and switchboard.

"Electron" is the interesting name chosen by the new publication of the Central Electric Company of Chicago, Ill. It is the aim of the new house organ to symbolically represent electrical power as the electron does in the present theory of constitution of matter. The first number, just distributed, is snappy and instructive.

A. L. Thorn, superintendent of the city electric works, Tacoma, states that the Nisqually power plant, put in operation more than four months ago by the city, has run to the present time without a shut down for repairs. It has also been discovered that the wheels at the works do not require half the water anticipated.

The Pacific Light & Power Corporation, Los Angeles, Cal., has ordered ten 5000 k.v.a. and three 1000 k.v.a. transformers, and the Great Western Power Company, San Francisco, Cal., will install in its station at Denverton, Cal., six 300 k.v.a. transformers and two panels; also three 300 kw. transformers in the station at Sheldon. The Ventura County Power Company at Oxnard, Cal., has ordered a 500 kw., 3000 r.p.m., 50 cycle, 2300 volt, turbo-generator set. All the foregoing will be supplied by the General Electric Company.

The Electric Safety Appliance Company, Tacoma, of which A. Z. Smith of the A. Z. Smith Electric Company is the prime mover, is getting ready to begin the manufacture of a safety appliance to be used in operating elevators and which is intended to work in such a manner that the elevator cannot be used when the doors are open. The patents cover the United States, Canada, England, France and Belgium. One of these appliances is to be installed in the new Central school building, Tacoma.

THE ELECTRICAL CONTRACTORS' DEPARTMENT

STANDARD SPECIFICATIONS FOR WIRING BUILDINGS.

(Continued.)

Example No. 4. For conduit work in a store, office or hotel building in the overhead district having only individual meters for the various tenants and no master meter.

Service.

(72) From a point fifteen (15) feet above the ground on the Portland Railway, Light and Power Company's pole on ..... Street, approximately ..... feet .....of .....Street, the wiring contractor is to run a set of 3-conductor service mains for the whole lighting system, in metal conduit, down the pole, under the sidewalk and through the basement floor to the main service switch and cutout located at point shown on basement plan. The top of the conduit on the pole is to be equipped with a Type "F" condulet.

(73) A set of service mains for the whole power system is to be run between the above-mentioned points in the same manner.

(74) At the point shown on basement plan, the wiring contractor is to furnish and install a service switch and enclosed fuse cutout for the entire lighting system, same to be enclosed in a sheet steel cabinet made up of not less than No. 12 sheet steel with a door of not less than No. 10 sheet steel, same to be fitted with a suitable spring latch and hinged at the top so as to be self-closing.

(75) At the same point, a service switch and cutout for the entire power system is to be furnished and installed in the same manner.

(76) From their respective main service switches the wiring contractor is to extend the service mains for the light and power systems to the meter board located at point shown on plans.

Meter Board.

(77) At the point shown on plans, the wiring contractor is to furnish and install a meter board of sufficient size to accommodate the necessary number of meters for the entire building, with at least 6 inches spacing between and around each meter. The board is to be made up of 1¼-inch thoroughly seasoned fir S. I. S. and of such dimensions and placed at such height that the highest meter will not be more than 7 feet from the floor nor the lowest meter less than 3 feet from the floor. On this board the wiring contractor is to furnish and install the necessary branch cutouts and wiring for the meters. The branch cutouts for the individual light and power meters are to be arranged along the lowest part of the board and enclosed in a covered trough or cabinet, and all wiring between same is to be on face of board. (See Portland Railway, Light and Power Company's blueprint D. F. 12, showing the above arrangement.)

Meters.

(78) Standard General Electric Company's recording wattmeters arranged for side connection will be furnished and installed by the Portland Railway, Light and Power Company, but all necessary wiring to and from same is to be furnished and installed by the wiring contractor.

Lighting Feeders.

Copy clause (65).

Power Feeders.

Copy clause (66) and last clause of Example 1.

Cutout Cabinets, Branch Circuits, Switches.

Same as Example 1.

Example No. 5—For Concealed Knob and Tube Work in a store, office or hotel building in the Overhead District having only individual meters for the various tenants and no master meter.

Service: Copy clauses (72) to (76) inclusive.

Meter Board: Copy clause (77).

Meters: Copy clause (78).

Lighting Feeders: Copy clause (65).

Power Feeders: Copy clauses (68) and (69).

Cutout Cabinets:

Copy clauses (70) and 71). Copy clauses (46) and (47).

Branch Circuits: Copy clauses (48) to (53) inclusive.

Switches: Copy clauses (54) to (60) inclusive.

Example No. 6—For Concealed Knob and Tube Work in an apartment building in the Overhead District, having individual meters for the various tenants and underground service down pole.

Service: Copy clauses (72) to (76) inclusive.

Meter Board: Copy clause (77).

Meters: Copy clause (78).

Lighting Feeders:

(79) From their respective meters on the meter board, feeders are to be run as follows:

(a) One 3-wire to the branch cutout cabinet in the janitor's quarters, same to be known as the house feeder.

(b) One 3-wire to the branch cutout cabinet in each of the apartments having more than 12-16 c.p. lamps or their equivalent. (80) For those apartments having 12-16 c.p. lamps or less, a 2-wire feeder is to be run direct to the lamp and switch outlets in those apartments.

Power Feeders:

(81) From the power meter on the meter board, a feeder is to be run to the elevator and terminated in a wooden switch cabinet, same to be thoroughly lined with asbestos and painted to comply with all rules and requirements. The door is to be fitted with a suitable spring latch and hinged at the top so as to be self-closing. In this cabinet is to be mounted a proper switch and cutout and provision made for future connection to motor leads.

Cutout Cabinets:

(82) In the janitor's apartment and in each of those apartments having more than 12-16 c.p. lamps or their equivalent, wooden cutout cabinets are to be furnished and installed, same to be lined with asbestos and painted to comply with all rules and requirements. The doors of same are to be fitted with suitable spring latches and hinged at the top so as to be self-closing. The wiring contractor is to furnish and install the cabinets complete. The cabinets are to contain the necessary three-to-two wire plug cutout branch blocks.

Copy clause (71).

Branch Circuits:

Copy clauses (48) and (49).

(83) From the branch cutout cabinet in the janitor's quarters the necessary branch circuits are to be run to the outlets for the lamps in the main entrance and in the common halls and stairways and in the common basement.

Switches:

(84) All ceiling outlets connected by curved lines to switch outlets, which are indicated thus ("S") on plans, are to be controlled by flush push button switches with face plates to match other hardware. There are to be separate snap switches located in the janitor's apartments to control the hall and stairway lamps on each floor.

(85) The lamps near the foot of the stairs in the basement are to be controlled by a rotary snap switch placed just inside of the door leading to the basement from the main entrance. The lamp in the main entrance is to be controlled by a rotary snap switch located in the janitor's apartments.

(86) All the ceiling outlets in the rooms are to be controlled by flush push button snap switches, located as shown on plans, with face plates to match other hardware.

(To be continued.)

INDUSTRIAL

WESTINGHOUSE OZONIZER.

The use of ozone as a purifying agent has now become a well established custom; the particular fields of application being in offices, clubs, school rooms, churches, theatres, dwellings and similar places.

Ozone is also found to be a preservative agent against mould and putrefaction in foods, and in pulmonary diseases gives relief and often effects a cure.

One Westinghouse ozonizer will generally produce sufficient ozone to purify the air in a room having an area of 40 square feet and the average height.

The ozone oxidizes the various animal and vegetable substances which it attacks and renders them odorless. In addition it also attacks bacteria and germs in the air, rendering the air sterile and healthful, a fact that makes the ozonizer particularly useful in hospitals, dispensaries and operating rooms.

The Westinghouse ozonizer consists of a step-up transformer, tubes for generating the ozone and a regulating switch, all contained in an easily portable case. The function of the transformer is to raise the voltage of the supply circuit to that required by the ozone generating tubes.

These tubes are of glass of special construction, having an outer coating of metal made to adhere closely to the glass by a special process. The inner walls of the tubes are lined with a metal mesh which forms the ozone generating surface.

Westinghouse Ozonizer.

The outer coating is connected to one terminal of the high tension winding of the transformer, and the inner coating is connected to the other high tension terminal. The uneven distribution of potential by the metal mesh on the inside of the tubes produces a large number of tiny brush discharges which generate ozone.

The generating cylinders are located above the transformer and stand vertically, so that the warm air rising from the transformer and from the inside of the generating tubes causes an upward draft, drawing in fresh air at the bottom and giving off a uniform flow of ozonized air at the top.

On top of the case is a knurled knob connected to the regulating switch located inside the case, which is connected to the generating tubes in such a manner that, by turning the knob to the positions indicated on the dial, the number of tubes in operation may be regulated from one to four, with a corresponding change in the unit of ozone.

The cylindrical part of the case is of heavy sheet metal and the top and bottom of wood. This wood is thoroughly seasoned, and heavy enough to prevent warping.

The ozonizer is furnished with either one of two kinds of finish; one being white enamel all over, which is intended for hospitals and dispensaries. The other finish is polished mahogany for the wooden top and bottom and dull black for the remainder of the case; this finish being recommended for offices, churches, and places having polished woodwork.

Although the voltage is stepped to a high value, the circuits are so thoroughly insulated, and all exposed metal parts are electrically connected together, so that no difference of potential can exist between them even though a part of the circuit should become grounded on the case.

The ozonizer is made by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

BENJAMIN SOCKET EXTENSION FOR 60 WATT UNSKIRTED BASE MAZDA LAMPS.

The lamp manufacturers are now furnishing the 60 watt Mazda lamp with unskirted medium screw base. The distance from the base contact to the center of the filament has thus been shortened approximately an inch and the proper relation between filament and reflector accordingly destroyed.

Benjamin Socket Extension for 60 Watt Unskirted Base Mazda Lamps.

The Benjamin socket extension No. 91 meets this condition by lengthening the sockets just enough to overcome the defect involved. The new lamp can thus be used without a change of reflector with proper lighting results. Other changes that can be made are from 60 watt skirted base Mazda to 40 watt Mazda; 40 watt Mazda to 10, 15, 20 watt Mazda; 100 watt Gem to 25 watt Mazda; 50 watt Gem to 10, 15, 20 watt Mazda.

NEW DEPARTURE IN SAWMILL DRIVE.

The Eagle Lumber Company at Timber, Oregon, are now building a new sawmill, in which a 22 in. x 20 in. heavy duty side crank Skinner automatic engine, is direct connected to the main line shaft. The engine speed is 210 r.p.m., steam pressure 125 lb., rating 600 to 800 h.p. This same engine in addition to driving line shaft is belted to head hand mill. Another 18 in. x 20 in. Skinner engine is belted to a smaller part of mill. The entire equipment of the mill, in addition to the above, was furnished by the Allis-Chalmers Company. The output of this mill will be 125,000 to 150,000 feet per day of 10 hours.

The Wheeler Lumber Company, of Wheeler, Oregon, are installing an installation, which is a duplicate of the Eagle Lumber Company's Mill, and the equipment is all furnished by the Allis-Chalmers Company.

NEWS NOTES

INCORPORATIONS.

OLALLA, WASH.—Olalla Telephone Company, $10,000, by H. F. Hall, John Karcher and others.

SACRAMENTO, CAL.—National Wireless Telephone & Telegraph Company of Arizona, $2,000,000, by L. Cassidy and others.

LOS ANGELES, CAL.—Gem Lake Power & Water Company; capital stock, $1,000,000; by J. H. McCarthy, W. A. Ramsay, H. V. Henry, J. T. Bunn and F. E. Edwards, directors.

SANTA BARBARA, CAL.—Articles of incorporation for the Domestic Water Company of Santa Maria have been filed. The company is capitalized for $250,000. The incorporators are C. H. Beus, T. A. Allan, A. H. Eddy, all of San Francisco.

SANTA ANA, CAL.—Articles of incorporation of the Dawn Water Company have been filed, with capitalization of $10,000. The incorporators are J. A. Nunn, R. J. Thompson and Harry Lewis. The new concern proposes to develop, acquire, distribute and sell water for irrigation purposes.

ILLUMINATION.

CONCONNULLY, WASH.—The electric plant owned by Morton & McDaniel was recently destroyed by fire.

ALHAMBRA, CAL.—The city council has awarded a contract for ornamental lighting posts for Garfield, Main and Fair Oaks avenue, to the Newberry-Bendheim Electric Company, for $20,456.

RIVERSIDE, CAL.—The Southern California Edison Company has been granted a franchise to construct and maintain for 50 years, poles, masts, and other superstructure, upon which to suspend wires, cables and other appliances for transmitting electricity.

OWENSMOUTH, CAL.—The Southern California Edison Company will begin the erection of a substation at the corner of Market street and Sherman way at once, for the purpose of furnishing light and power to Owensmouth. F. O. Engstrum Company of Los Angeles, have the contract for the building.

SEATTLE, WASH.—The Seattle Lighting Company, S. R. Hutchinson, superintendent, has filed a new rate on gas with the public service commission, same to take effect on and after April 1st. The rate provides for the first 5000 cubic feet at $1000 per thousand, the next 35,000 cubic feet at 80 cents per thousand, the next 60,000 at 70 cents per thousand and all over 100,000 cubic feet at 60 cents per thousand.

GRANTS PASS, ORE.—By a decision handed down by Judge Bean in the United States District Court, the city council of Grants Pass received notification that it was not permitted to interfere with the rulings of the State Railroad Commission, when it had fixed rates under the utility act. The California & Oregon Power Company had been supplying that city with power and illumination at a rate that the council determined was too high. An ordinance reducing the rates was passed, notwithstanding the commission's schedule. In his decision Judge Bean held the state board has unquestioned authority in the matter, and that its rates should be operative until the city of Grants Pass could have them changed by that body.

SAN FRANCISCO, CAL.—The Pacific Gas & Electric Company has been awarded by the Panama-Pacific International Exposition Company contracts for supplying electricity for light and power, gas for illumination and steam for heating purposes. The work of installation will be commenced at once, the contracts calling for the service to extend through the period of construction and during the season of the exposition. The electric contract specifies a minimum installed capacity of 12,000 h.p. during the constructive period of the exposition and 20,000 h.p. after the gates have been opened. The Pacific Company will construct a generating station on the exposition grounds. This will be an auxiliary to the company's big plant in the Potrero and will also be the company's exhibit at the exposition, the building being open to visitors during the regular visiting hours. The steam contract calls for 30,000 pounds of steam per hour from 10 a. m. until 5 p. m. Gas will be supplied from the plant at the foot of Hyde street. It is estimated that the gross revenues will amount to $500,000.

TRANSMISSION.

PLUMAS, CAL.—The Indian Valley Electric Light & Power Company is making arrangements to enlarge its plant to 30,000 h.p.

BEND, ORE.—The Bend Water, Light & Power Company has commenced the installation of a power line to the planing mill south of Bend. Cedar poles will be used.

BURNABY, B. C.—Superintendent Wm. McNeill of the Western Canada Power Company, states that the power line across Burnaby to N. Arm Frasier River and Lulu island is contemplated.

OCEANSIDE, CAL.—F. F. Foster & Company, of Los Angeles have been awarded the contract to build a power line from Oceanside to San Luis Rey for the Oceanside Electric Company. The line is to furnish power for pumping for irrigation, also for lighting purposes.

TUCSON, ARIZ.—The Borderland Mines Company has completed financing of a power plant to be located at Calabasas. The line will run to Oro Blanch through the Santa Cruz valley, furnishing cheap power to mines in that section. Tood C. Woodworth is president of the company.

WENATCHEE, WASH.—William F. Scheffel, believed to represent the Edison Electric Company, has filed on 25,000 inches of water per second of the Columbia River water at Rock Island, to be used in development of electric power for irrigation, lighting, heating, pumping and mechanical purposes.

MARYSVILLE, CAL.—Application has been made to the board of supervisors, by the Great Western Power Company, for a franchise to erect lines, etc., for transmitting electricity along certain streets and highways in the county of Yuba. Sealed bids will be received up to 11 a. m. April 9th, for the sale.

VISALIA, CAL.—Application has been made by Albert C. Agnew to the board of supervisors of Tulare county, for a certain franchise granting the right to construct and for a period of 50 years operate an electric tower and wire system across certain public highways, in said county. Similar applications have been made in Glenn, Colusa, Butte and Shasta counties.

CHICO, CAL.—The city trustees turned down the application of the Sierra Electric Power Company for a franchise to serve the people of this city with electricity. The local field is now covered by the Pacific Gas & Electric Company and the Northern California Power Company. The Sierra company is getting a county franchise, and also permits in many cities of the valley, its plant is to be located at Manton, Tehama county.

LOS ANGELES, CAL.—Official call for an election to vote bonds in the sum of $17,600,000 has been issued, setting the date for the election April 15th. All of the propositions submitted with the exception of the issue of $1,000,000 for water main extension were placed on the ballot. The projects and amounts called for on the ballot are: Aqueduct power-distributing system, $6,500,000; Chatsworth line of aqueduct, $2,000,000; Franklyn canyon line, $1,500,000; San Dimas high line, $2,500,000; harbor improvements, $2,500,000; new city hall, $1,000,000; normal school site, $600,000, and municipal railroad, $1,000,000.

TRANSPORTATION.

REDDING, CAL.—Albert C. Agnew has applied to the supervisors for a franchise on the highways of Shasta county for an electric railroad and to build a power line. Agnew has made a similar application to the city trustees of Redding. The board has ordered the sale of the franchise advertised. Oakland capitalists are supposed to be interested in the proposed electric railroad.

SAN FRANCISCO, CAL.—The Ocean Shore Railroad Co. has applied to the Railroad Commission for authority to issue $700,000 of 6 per cent bonds, maturing in 1916. It is stated in the application that the capital to be thus secured is to be used for the purchase of land for right of way purposes upon which the Ocean Shore at present has only a leasehold, and for the purchase of the property for right of way purposes; for the purchase of equipment; for compliance with possible franchise requirements in the city of San Francisco, and for making preliminary changes. The application states that the cost of these improvements will be $250,000. The company asks authority to pledge the $700,000 of bonds as collateral security for a loan of $250,000, to be negotiated with the Union Trust Company of San Francisco.

TELEPHONE AND TELEGRAPH.

ALTURAS, CAL.—Application has been made to the board of supervisors for a telephone and telegraph franchise in the county of Modoc. Sealed bids will be received up to April 8th, for the sale of said franchise.

VISALIA, CAL.—An application has been made to the board of supervisors for a franchise for a period of 50 years to erect and operate a telephone line in certain highways of Tulare county. Sealed bids will be received up to April 8th, for th sale of said franchise.

VANCOUVER, B. C.—The British Columbia Telephone Company has awarded a contract to Coughlan & Sons for the supply of steel work for the big central exchange to be built on Seymour street, between Georgia and Robson streets. A contract was also awarded to Brooks & Weidopp for excavating work in connection with the new plant building of the company to be built on Front street.

WATERWORKS.

FULLERTON, CAL.—Sealed bids will be received up to March 17th for all labor and material required to construct service connections for the distributing system of the Fullerton Municipal Waterworks.

SUISUN, CAL.—At a meeting of the board of trustees a bid was received from G. G. Blymyer & Company, of San Francisco for the purchase of $20,000 water bonds issue of Suisun and the same was accepted by the board.

DAYTON, ORE.—The recent election carried in favor of issuing bonds in the sum of $12,000 for improvement to the local water system. The entire system will be overhauled and renewed with new pipes for the entire city.

SOUTH VANCOUVER, B. C.—Estimates aggregating $182,000 for waterworks purposes next year have been submitted to the council by Water Superintendent Joseph Mullett. The estimates include $14,736 for pumping station; and $83,836 and $66,278 for construction purposes.

GOLDENDALE, WASH.—The city council has adopted an ordinance providing for repairs and additions to the water system and calling an election to vote bonds for the work. New concrete reservoirs, new wood stave pipe are included in the work, which is to cost in the neighborhood of $25,000, for which amount bonds will be voted.

SONOMA, CAL.—The Sonoma Valley Water, Light & Power Company has let a contract to Contractor Volquardsen to sink a series of artesian wells on the Gilbert place. It is the intention of the water company to erect a pumping station on the property and install a pump capable of forcing 300,000 gallons of water through the pipe per minute.

LINTON, ORE.—Bonds have been voted in the sum of $100,000 for the purpose of installing a water system. An engineer will be employed at once to make the survey and prepare plans and specifications. The bonds will run thirty years; interest 3½ per cent. They have already been contracted to Morris Bros. of Portland. The plant is to be connected with the city of Portland mains and a contract will be let within sixty days.

OAKLAND, CAL.—The petition of the people of Oakland to the supervisors of Alameda county to have called a water-district election has been filed with the county clerk. The petition of other municipalities to be included in the district had been filed previously, so that the initial step toward the municipal ownership of water supply for the east bay community has been completed. The county clerk will have ten days in which to verify the signatures and the petitions will then be filed with the supervisors. On March 17, providing the county clerk finds the petitions correct, the supervisors will announce the calling of an election at which the people of the proposed metropolitan water district will be asked to vote for or against the establishment of such a district. The municipalities included and their several mayors who have been working for the creation of the district are as follows: Oakland, Berkeley, Alameda, Albany, Piedmont, Emeryville and San Leandro. The district extends from the Contra Costa county line of Albany to Alvarado, excluding the town of Haywards.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

March 3.

A complaint was filed by citizens of Jamestown, asking that the Railroad Commission regulate the rates and service of the Tuolumne County Electric Power & Light Company.

The Pacific Gas & Electric Company applied for permission to devote a portion of the proceeds received from the sale of its last issue of $5,000,000 of bonds upon the enlargement of the Bear River Canal. This canal will carry water from Lake Spaulding reservoir and will make it available for irrigation purposes in Placer county.

An order was issued extending until March 10th the effective date of a previous order authorizing the physical connection between the Pacific Telephone & Telegraph Company and the Tehama County Telephone Company and the Glenn County Telephone Company.

March 4.

A supplemental order was issued allowing the Southern Counties Gas Company to issue $5500 of bonds under a previous authorization.

March 5.

The Pacific Telephone & Telegraph Company applied for authority to install a telephone plant at Greenfield, Monterey county.

The Great Western Power Company applied for a certificate of public convenience and necessity to serve Yuba county and the city of Marysville with electricity.

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